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Kadobayashi et al.

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(54) **SUSPENSION DEVICE FOR OUTBOARD MOTOR AND VESSEL PROPULSION APPARATUS**

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Mar. 22, 2012 (JP) 2012-065802
Mar. 22, 2012 (JP) 2012-065803

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B63H 20/10 (2006.01)
B63H 20/00 (2006.01)

(52) **U.S. Cl.**
CPC ***B63H 20/12*** (2013.01); ***B63H 20/10*** (2013.01); ***B63H 21/26*** (2013.01)

(58) **Field of Classification Search**
CPC B63H 20/08; B63H 21/265; B63H 20/10; B63H 20/12
USPC .... 440/53, 58, 59; 114/144 R, 144 RE
See application file for complete search history.

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Primary Examiner — Edwin Swinehart
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

A suspension device includes a clamp bracket, a tilting shaft, a swivel bracket, a steering shaft, a case, an electric motor, and a transmitter. The electric motor and the transmitter are held in the interior of the case. The electric motor produces power to rotate the steering shaft about a central axis of the steering shaft. The transmitter transmits power from the electric motor to the steering shaft side. The case is located on a placing portion provided on the swivel bracket, and removably attached to the swivel bracket.

18 Claims, 23 Drawing Sheets

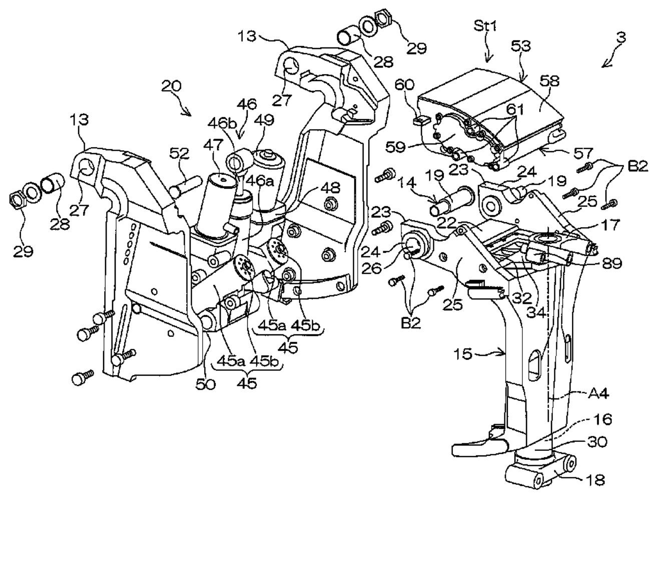


FIG. 1

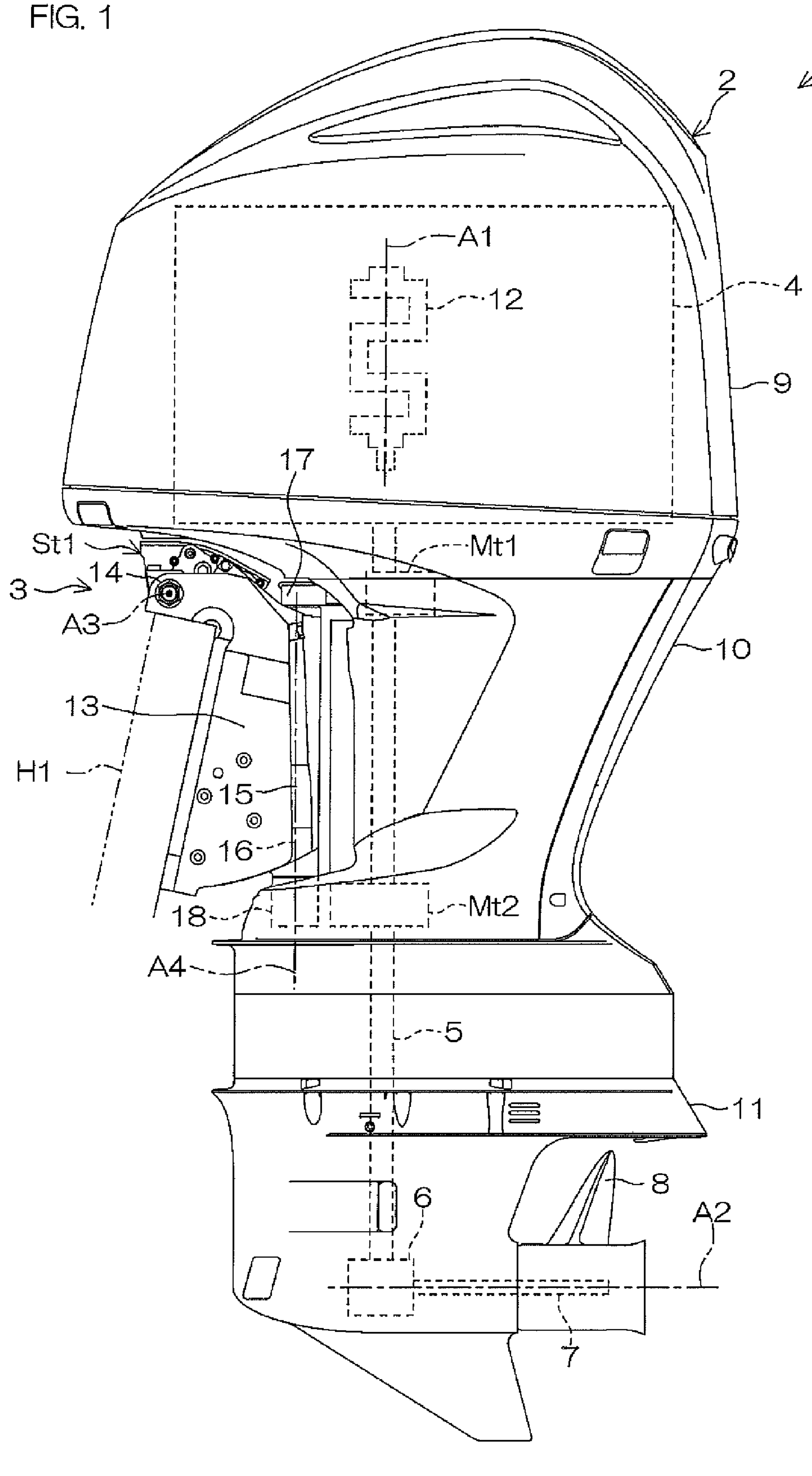
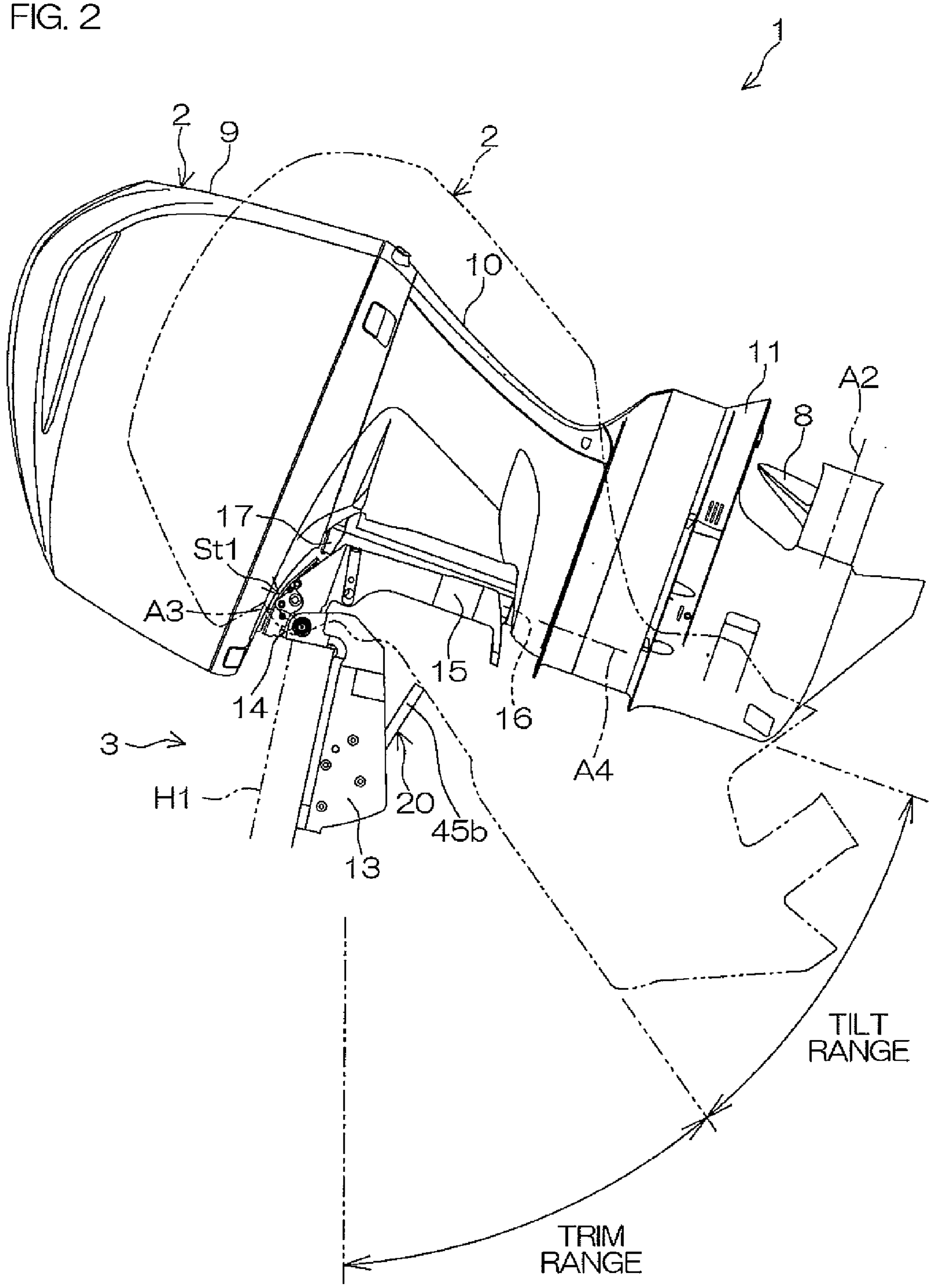


FIG. 2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TILT
RANGE
TRIM
RANGE

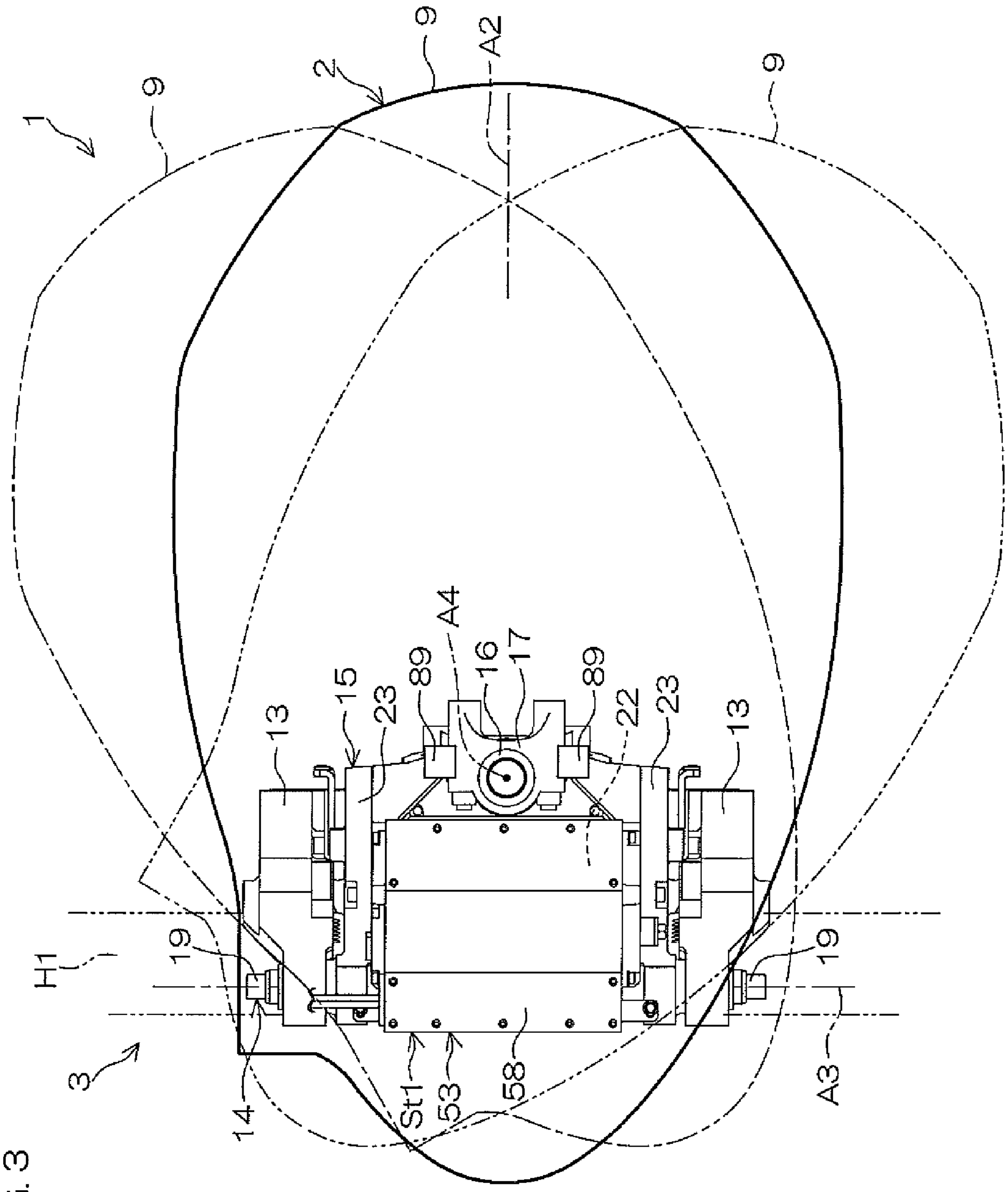
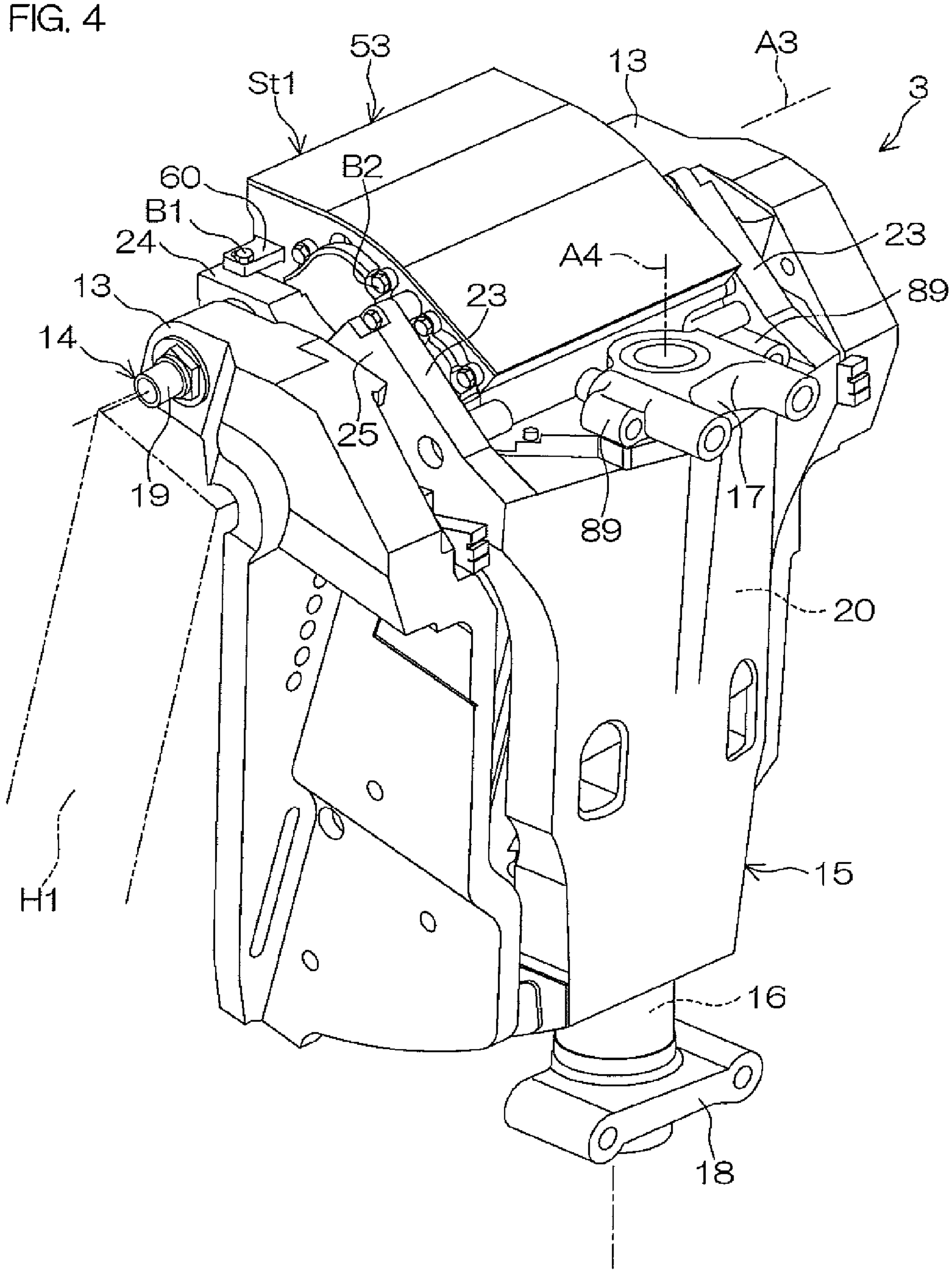


FIG. 3

FIG. 4



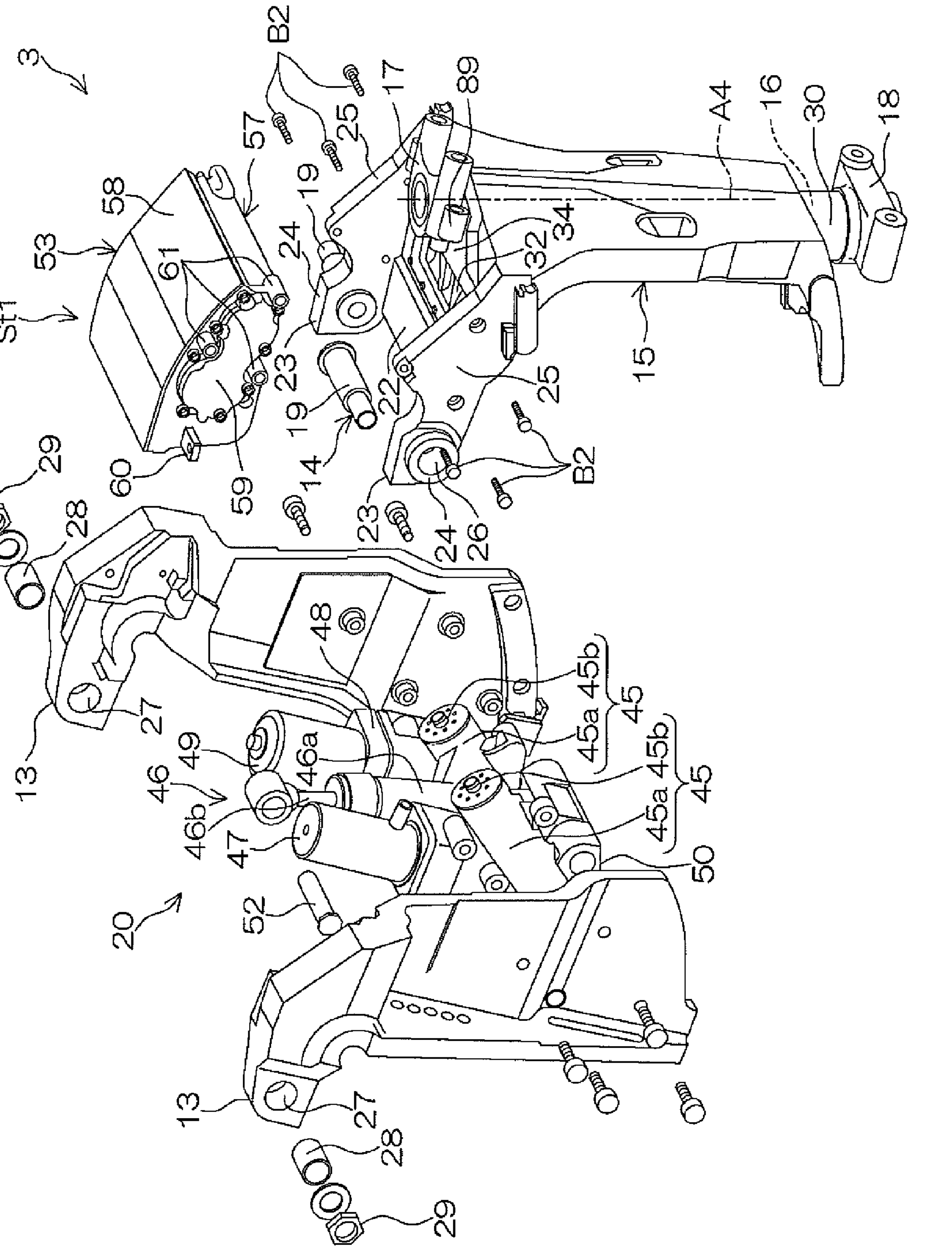

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FIG. 5

FIG. 6

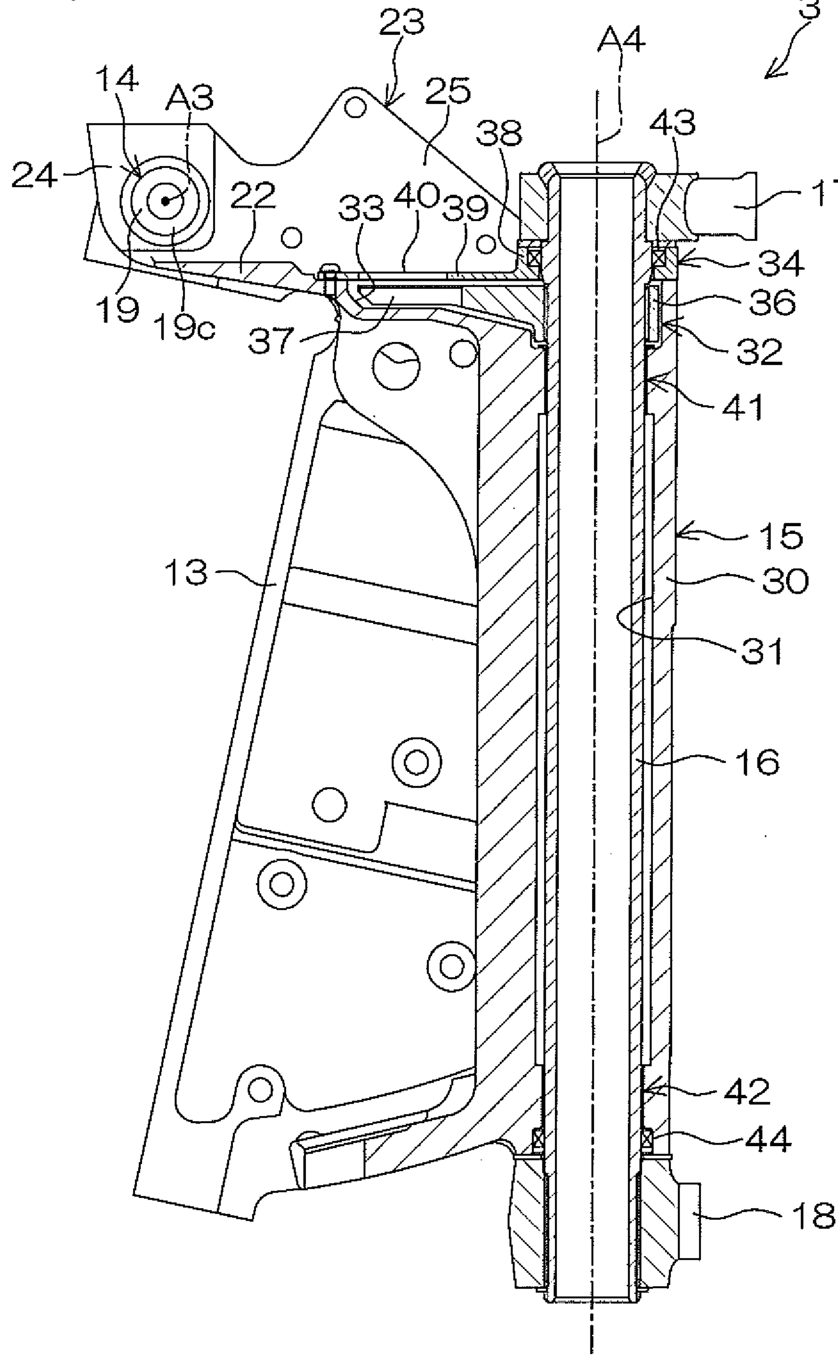
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FIG. 7

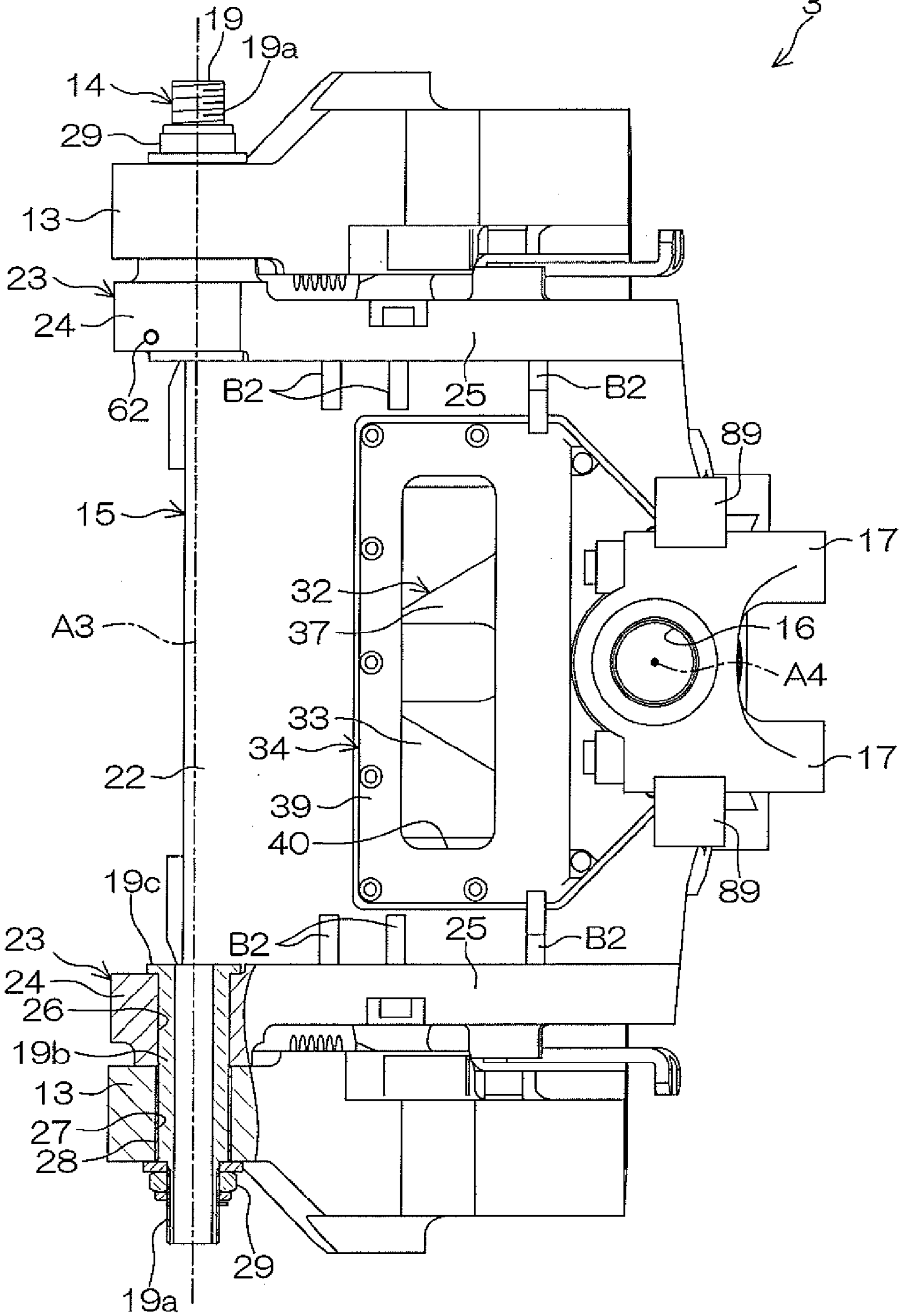
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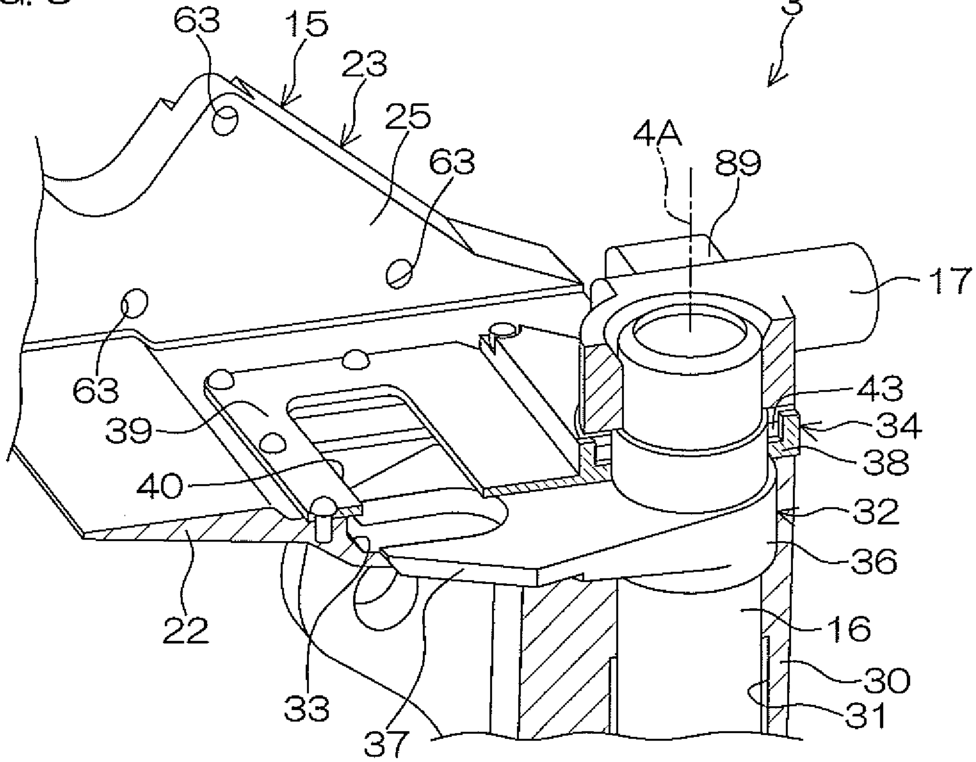
FIG. 8



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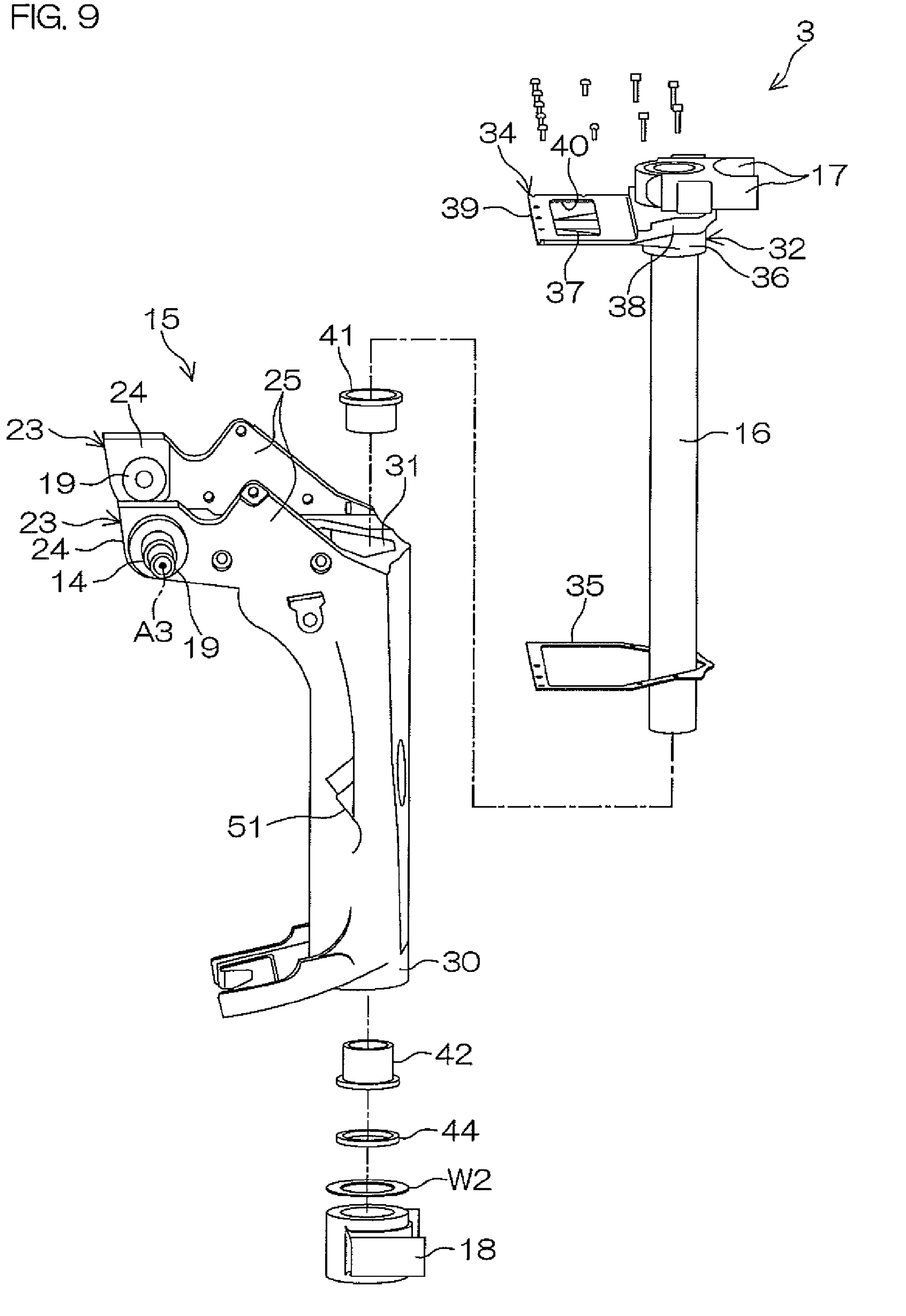
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W2
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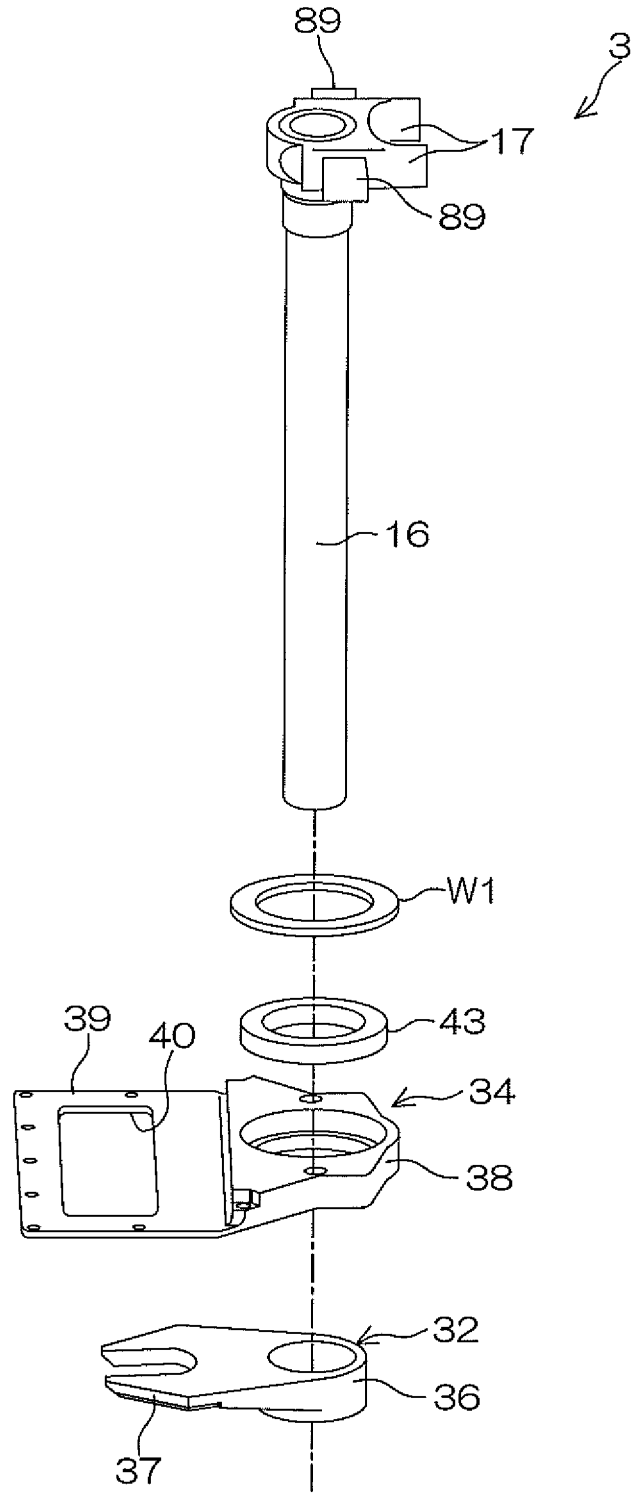
FIG. 10



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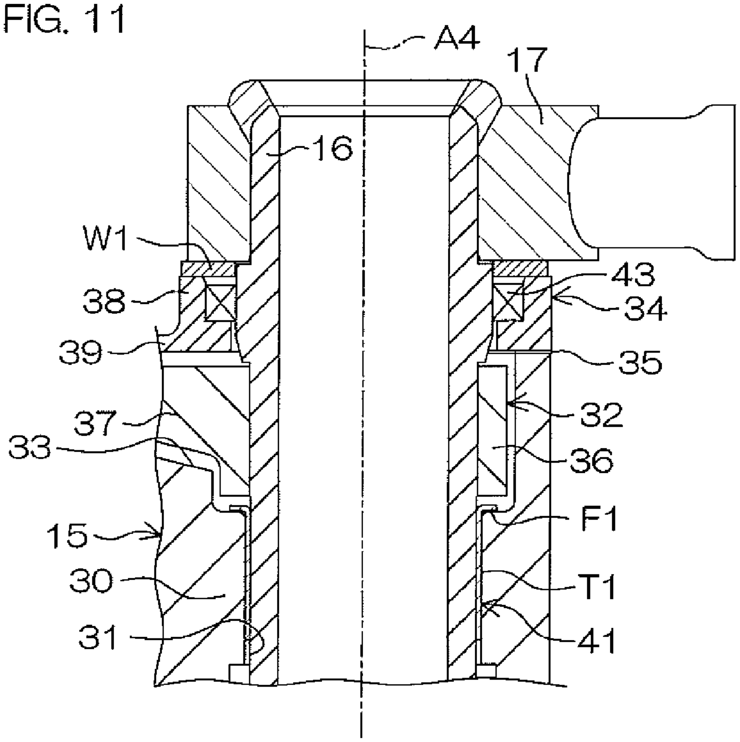
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FIG. 12

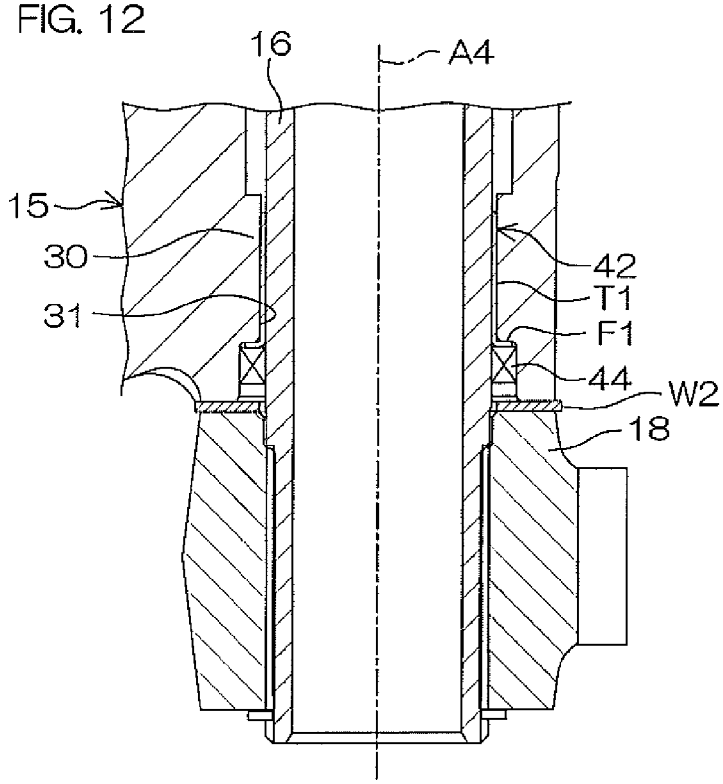
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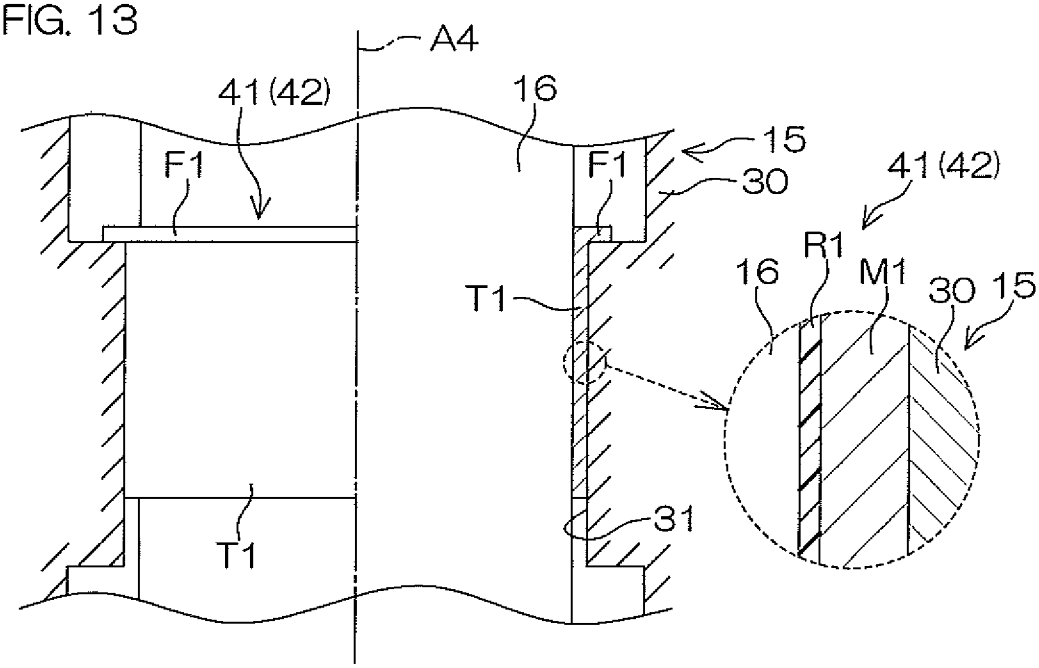
FIG. 13



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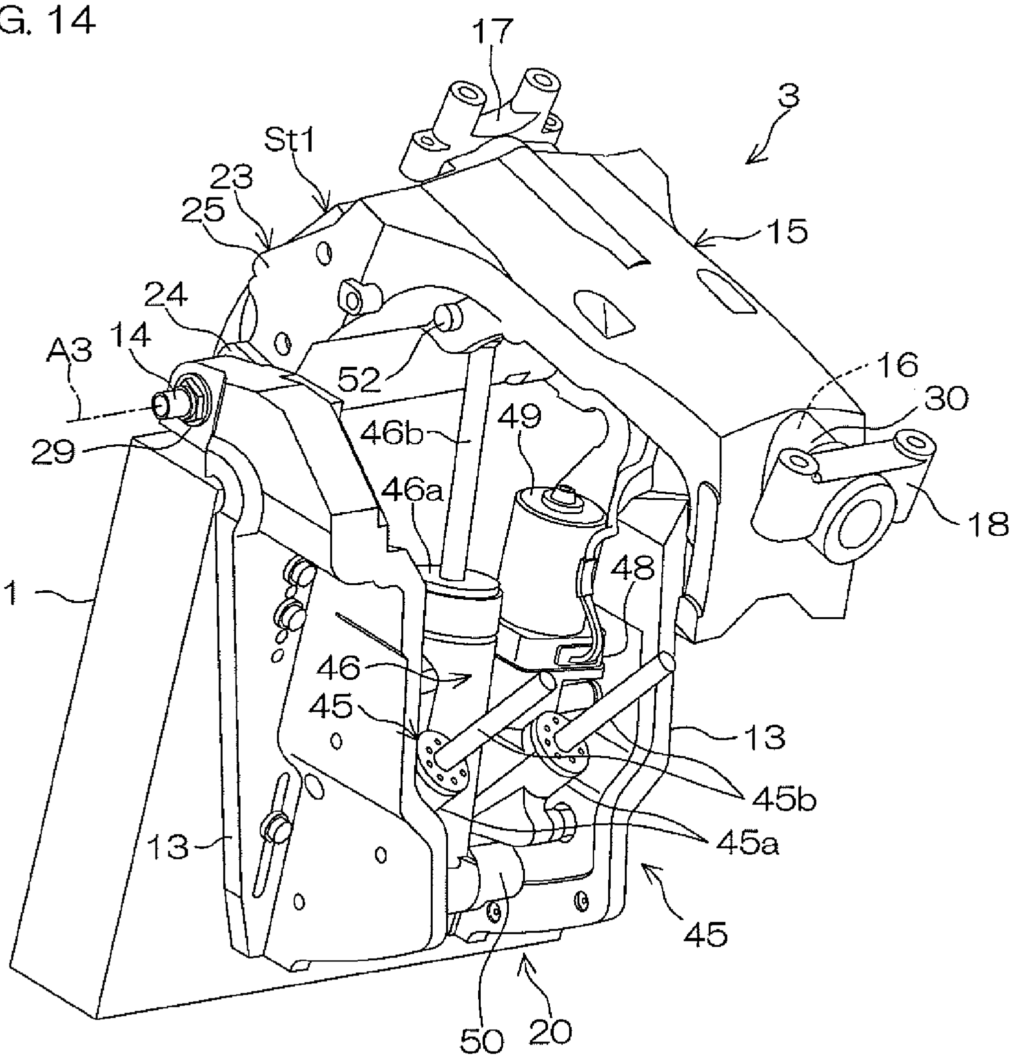
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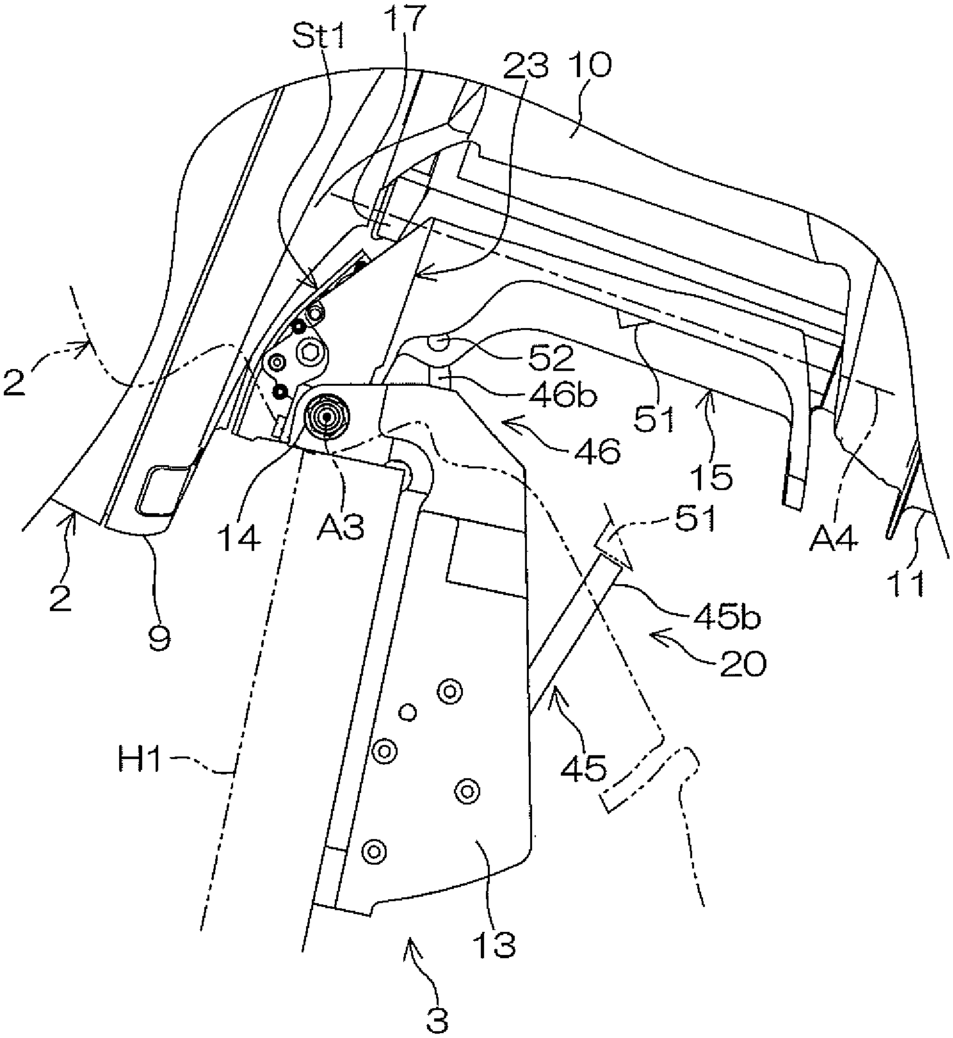
FIG. 15



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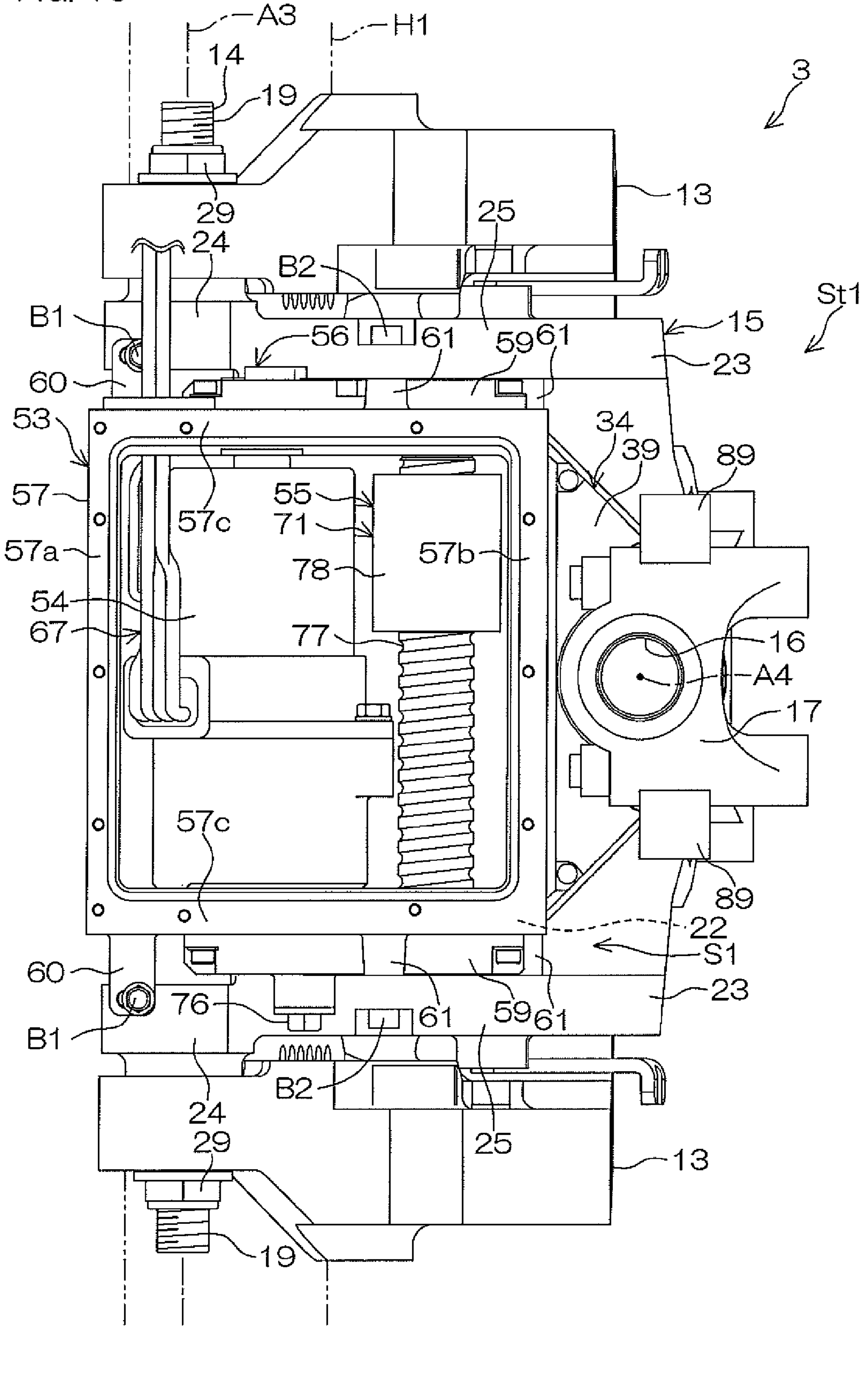
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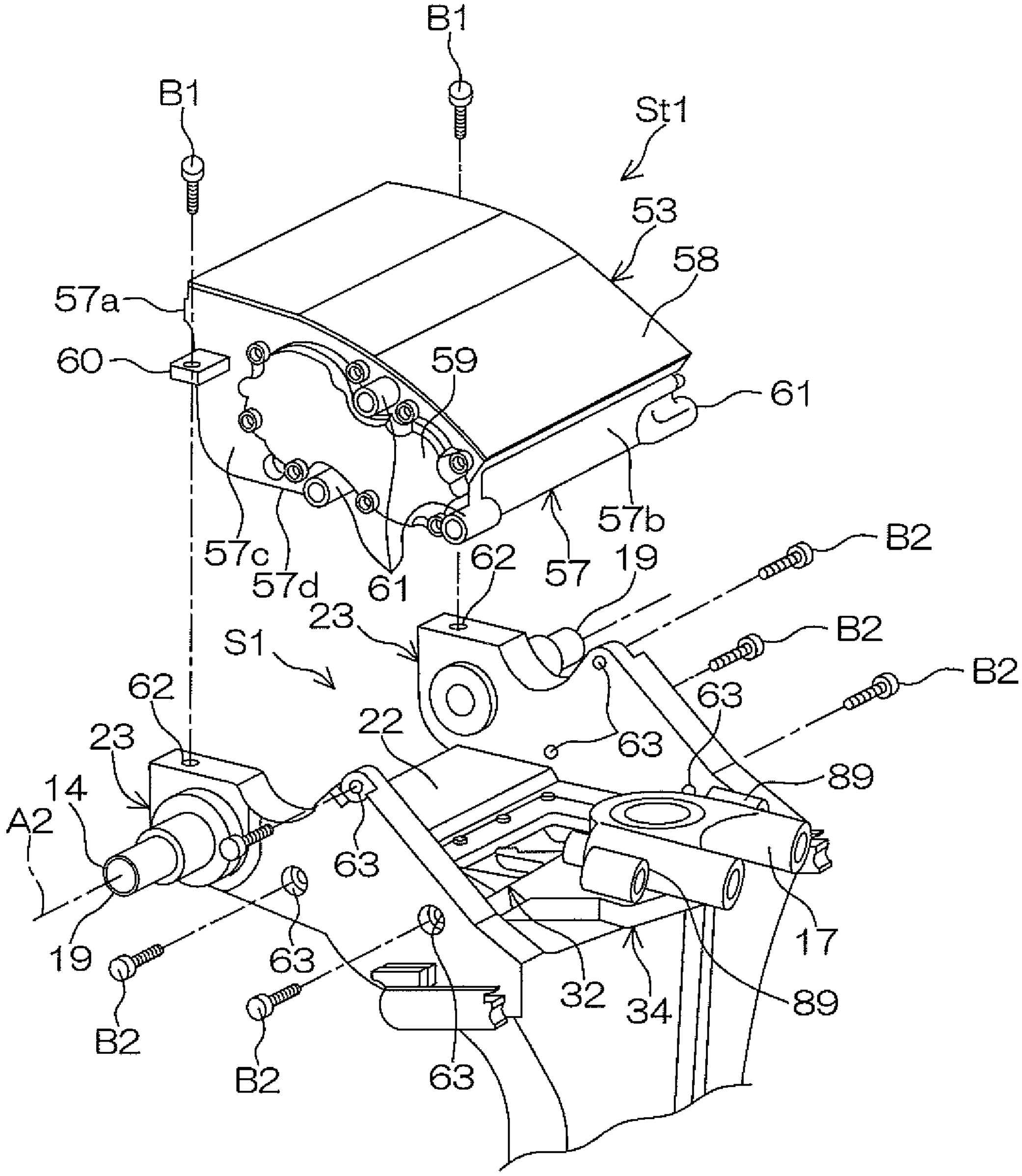
FIG. 17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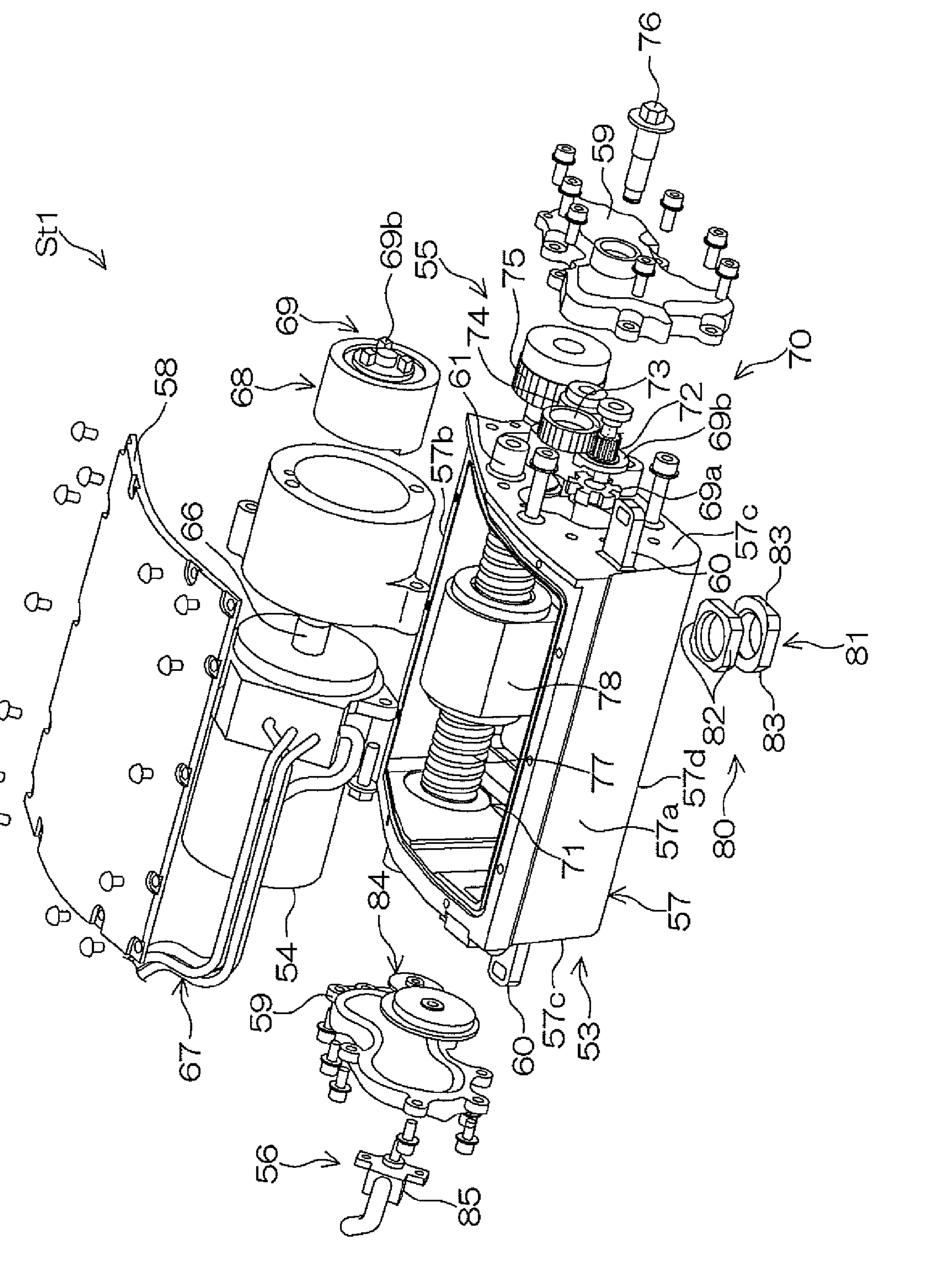
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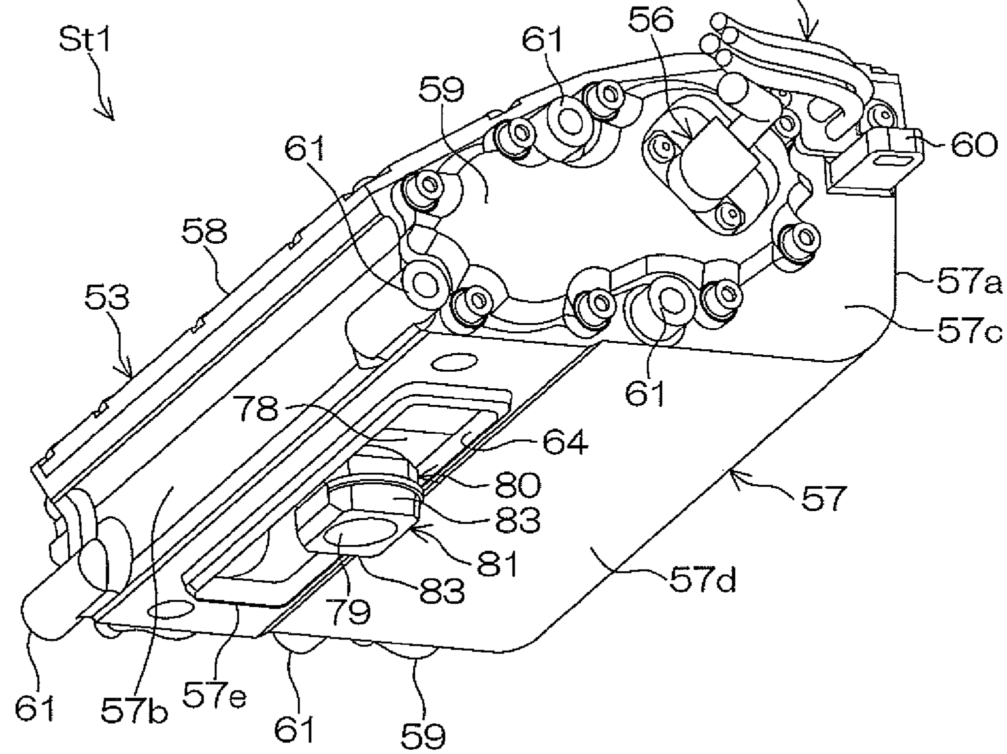
FIG. 18

FIG. 19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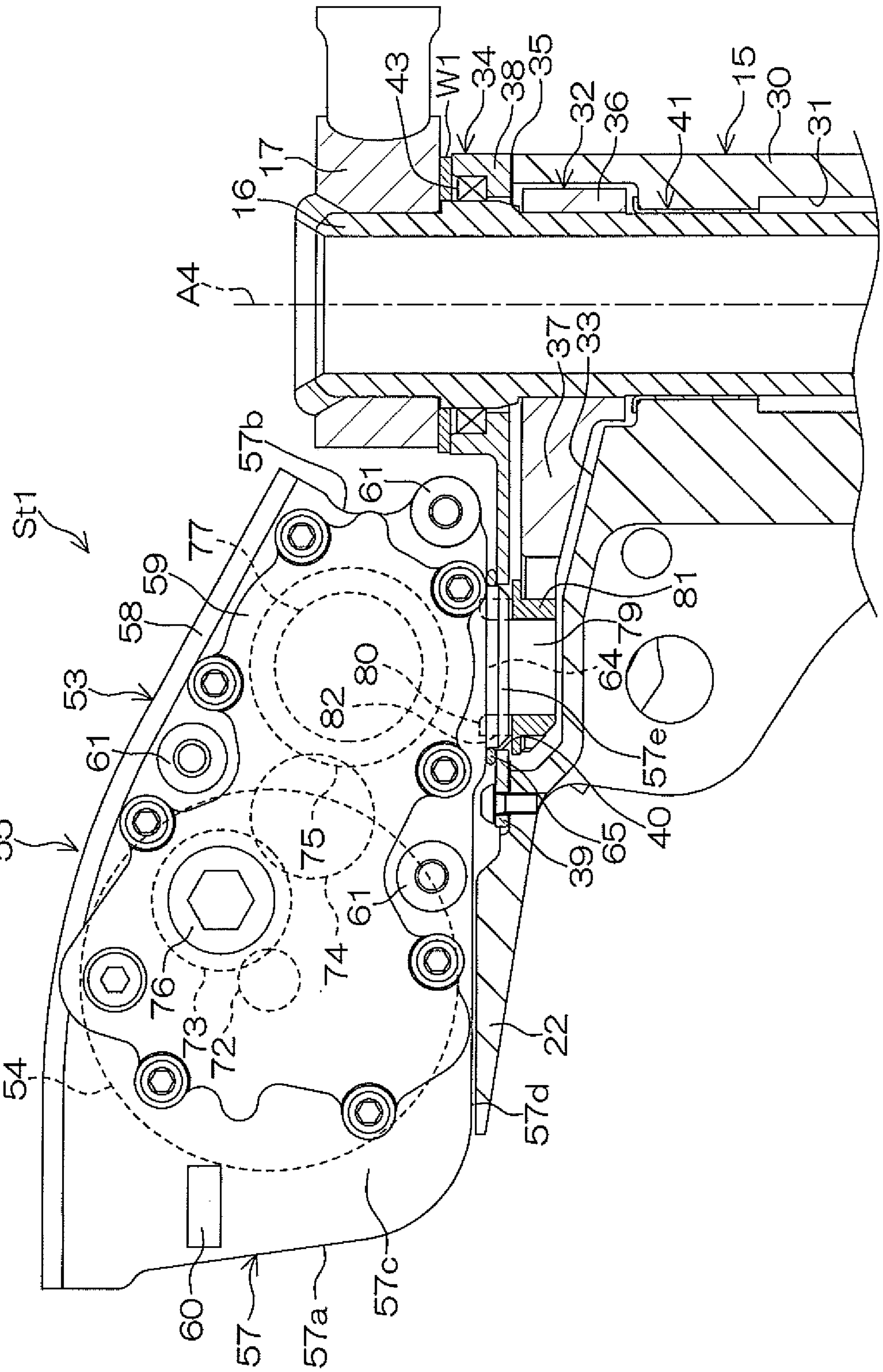
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FIG. 20

FIG. 21

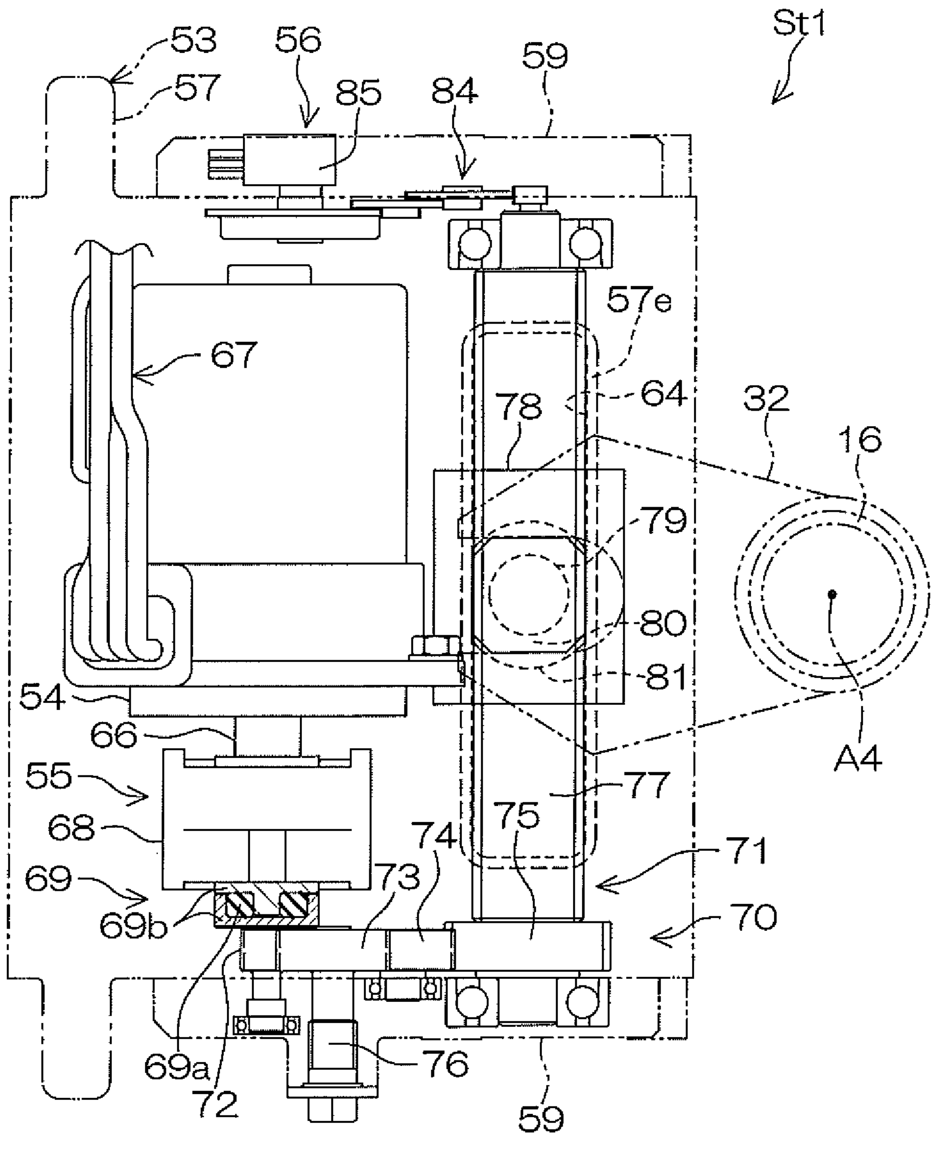
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FIG. 22

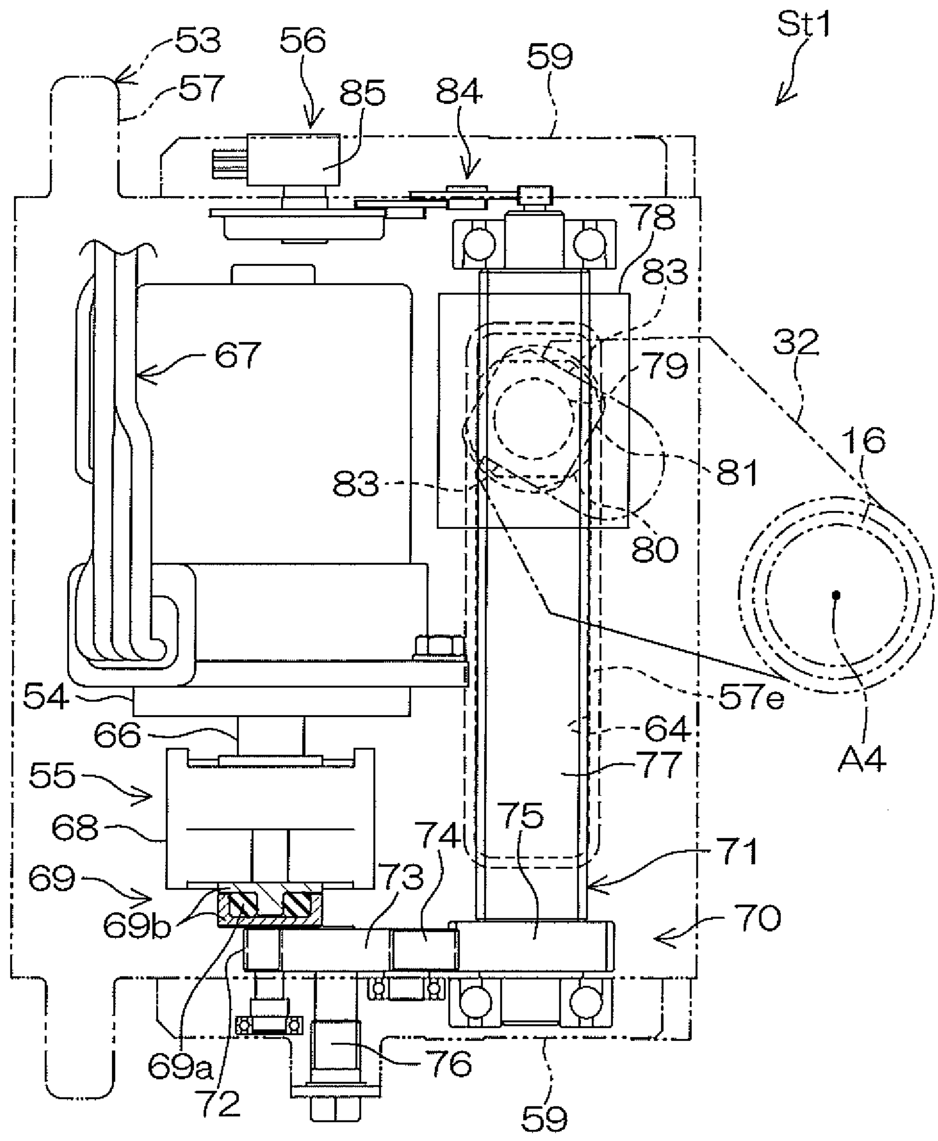
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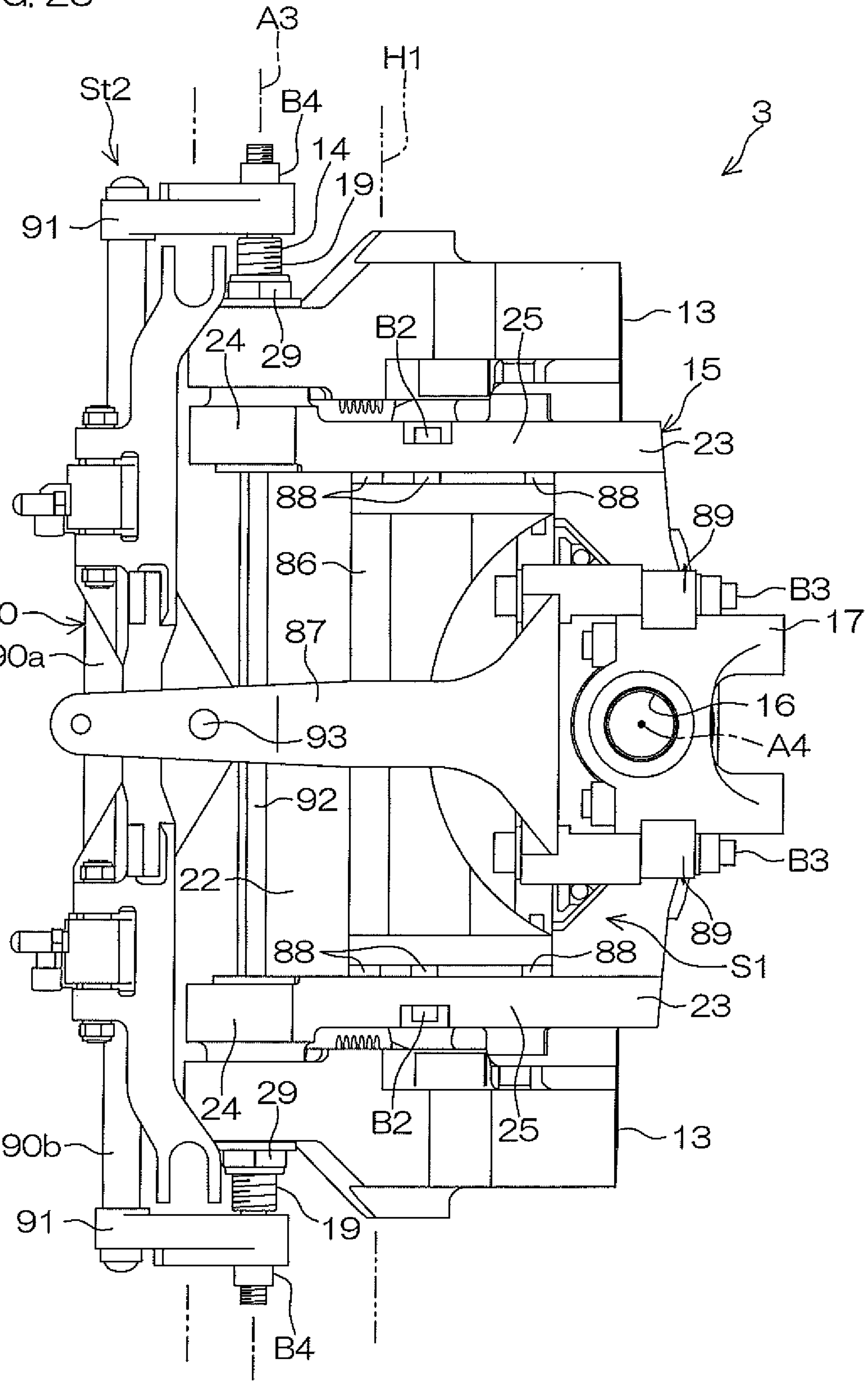
FIG. 23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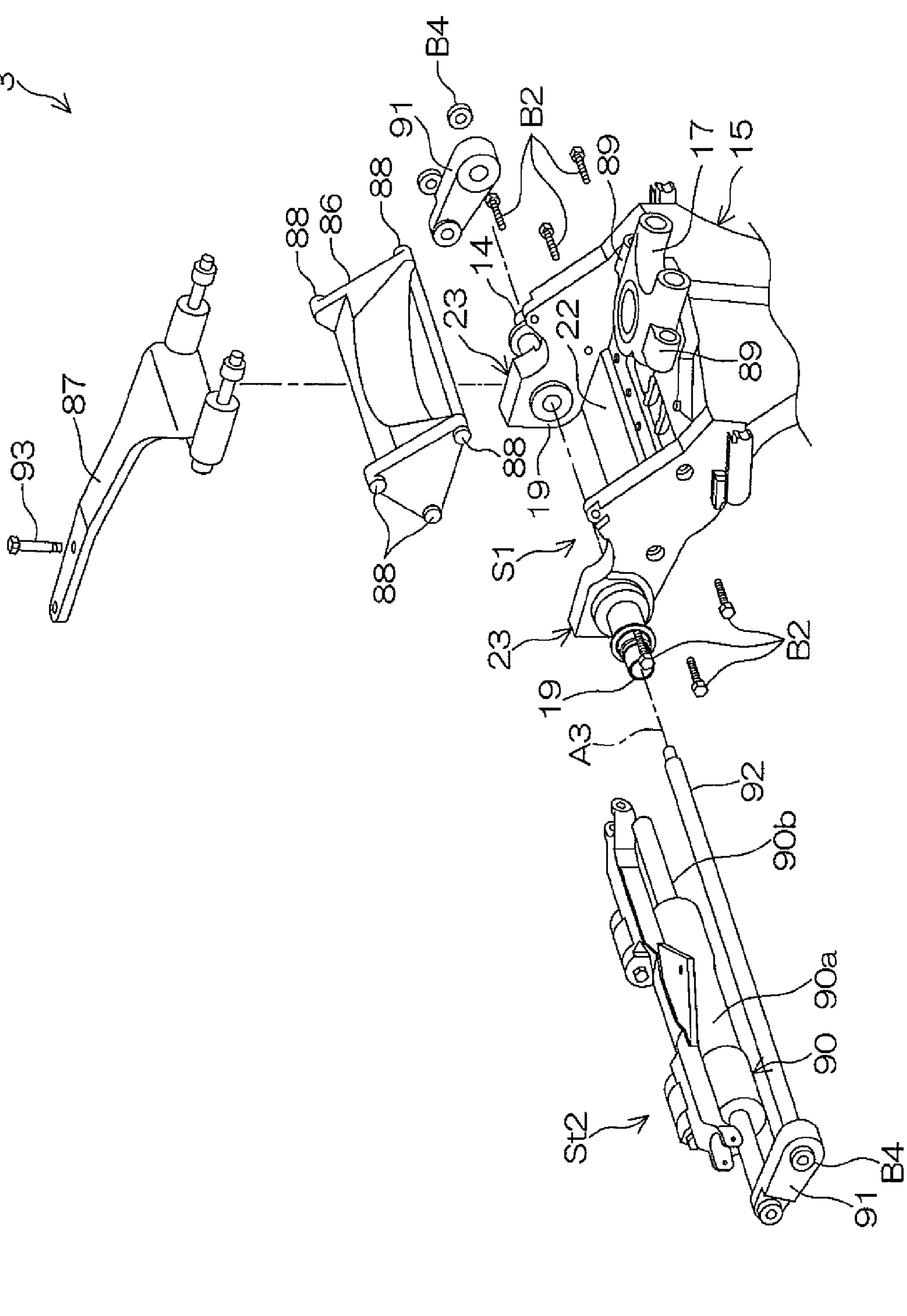
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FIG. 24

SUSPENSION DEVICE FOR OUTBOARD MOTOR AND VESSEL PROPULSION APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a suspension device which attaches an outboard motor to a hull, and also relates to a vessel propulsion apparatus which propels a vessel.

2. Description of the Related Art

Outboard motors are attached to hulls by suspension devices. Japanese Unexamined Patent Application Publication No. 2010-173446, Japanese Unexamined Patent Application Publication No. 2010-162999, Japanese Unexamined Patent Application Publication No. 2010-162992, and Japanese Unexamined Patent Application Publication No. 2009-83596 disclose suspension devices including electric steering mechanisms. These electric steering mechanisms are attached to swivel brackets that support outboard motors. The electric steering mechanisms are partially integrated with the swivel brackets.

However, in Japanese Unexamined Patent Application Publication No. 2010-173446, Japanese Unexamined Patent Application Publication No. 2010-162999, Japanese Unexamined Patent Application Publication No. 2010-162992, and Japanese Unexamined Patent Application Publication No. 2009-83596, because the electric steering mechanism is partially integrated with the swivel bracket, the whole of the electric steering mechanism cannot be removed from the swivel bracket even when the electric steering mechanism is unnecessary. Specifically, even if some components such as an electric motor are removed, the portion integrated with the swivel bracket remains. Therefore, the weight of the suspension device cannot be greatly reduced when the electric steering mechanism is unnecessary. Further, when the electric steering mechanism is damaged, it is necessary to replace not only the electric steering mechanism but also the swivel bracket. Furthermore, when maintenance of the electric steering mechanism is performed, because it is necessary to handle the electric steering mechanism and the swivel bracket as a single unit, the maintenance cannot be efficiently performed.

SUMMARY OF THE INVENTION

In order to overcome the previously unrecognized and unsolved challenges described above, a first preferred embodiment of the present invention provides a suspension device for an outboard motor, including a clamp bracket, a tilting shaft, a swivel bracket, a steering shaft, a holding member, an electric motor, and a transmitter. The clamp bracket is to be attached to a hull. The tilting shaft is connected to the clamp bracket. The swivel bracket is connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket. The steering shaft is held by the swivel bracket rotatably about a central axis of the steering shaft. The steering shaft is to be connected to an outboard motor. The electric motor produces power to rotate the steering shaft about a central axis of the steering shaft. The transmitter transmits power from the electric motor to the steering shaft side. The electric motor and transmitter are held by the holding member. The holding member is located on a placing portion provided on the swivel bracket. The holding member is removably attached to the swivel bracket.

According to this arrangement, the steering shaft to be connected to an outboard motor is held by the swivel bracket rotatably about a central axis (hereinafter, referred to as a

"steering axis") of the steering shaft. The swivel bracket is connected to the tilting shaft, and the tilting shaft is connected to the clamp bracket to be attached to a hull. The suspension device includes an electric steering mechanism that causes the steering shaft to turn about the steering axis. Specifically, the suspension device includes a holding member located on a placing portion provided in the swivel bracket, an electric motor which produces power, and a transmitter which transmits power from the electric motor to the steering shaft side.

The holding member is removably attached to the swivel bracket. The electric motor and the transmitter are held by the holding member. Therefore, by removing the holding member from the swivel bracket, the holding member, the electric motor, and the transmitter can be removed all at once from the swivel bracket. Thus, the electric steering mechanism can be maintained in a state removed from the swivel bracket. Consequently, maintenance can be performed more efficiently than when the electric steering mechanism is integrated with the swivel bracket. Further, the weight of the suspension device can be greatly reduced when the electric steering mechanism is unnecessary. Furthermore, it is not necessary to replace the swivel bracket when the electric steering mechanism is damaged.

In the first preferred embodiment of the present invention, the suspension device preferably further includes a steering arm connected to the steering shaft, and arranged to rotate together with the steering shaft about a central axis of the steering shaft. In this case, the suspension device is preferably arranged to be able to turn the outboard motor by transmitting power to the steering arm from the transmitter.

Moreover, in the first preferred embodiment of the present invention, the holding member preferably includes a case that holds the electric motor in the interior of the case and is provided with a first opening. In this case, the transmitter preferably transmits power from the electric motor to the steering shaft side through the first opening.

Moreover, in the first preferred embodiment of the present invention, the suspension device preferably further includes a steering arm connected to the steering shaft, and rotating together with the steering shaft about a central axis of the steering shaft. The holding member preferably includes a case that holds the electric motor in the interior of the case. The swivel bracket preferably includes an arm housing portion, in which the steering arm is housed, communicating with a first opening provided in the case. The transmitter is preferably transmits power on a transmission channel that extends to the exterior of the case from the interior of the case through the first opening, and connects the electric motor and the steering arm.

Moreover, in the first preferred embodiment of the present invention, the suspension device preferably further includes a first seal disposed between the case and the swivel bracket, and surrounding the first opening of the case. The first seal may preferably be a gasket or an O-ring, for example.

In the first preferred embodiment of the present invention, the suspension device preferably further includes a fastening member fastening the case and the swivel bracket with the first seal sandwiched between the case and the swivel bracket. The fastening member may preferably be a bolt, a hook, or a band, for example.

Moreover, in the first preferred embodiment of the present invention, the suspension device preferably further includes an arm cover covering the arm housing portion, and including a second opening arranged to cause the first opening of the case and the arm housing portion to communicate with each other. In this case, the suspension device preferably further includes a second seal disposed between the arm cover and the swivel bracket. The second seal may preferably be a gasket or an O-ring, for example.

Moreover, in the first preferred embodiment of the present invention, the suspension device preferably further includes a connecting member removably connecting the holding member and the swivel bracket.

Moreover, in the first preferred embodiment of the present invention, the swivel bracket preferably includes a pair of wall portions disposed on both left and right sides of the placing portion, and connected to a side portion of the holding member. In this case, the connecting member preferably includes a bolt, for example, that removably connects a side portion of the holding member and the pair of wall portions. Moreover, the suspension device preferably further includes a boss portion projecting from at least one of the holding member and the swivel bracket, and interposed between a side portion of the holding member and the pair of wall portions.

Moreover, in the first preferred embodiment of the present invention, the suspension device preferably further includes a turning angle detector held by the holding member, and arranged to detect a rotation angle of the steering shaft. According to this arrangement, because the electric motor is controlled based on a detection value of the turning angle detector, a rotation angle of the steering shaft, that is, a turning angle of the outboard motor can be controlled with high accuracy. Further, because the turning angle detector is held by the holding member, the holding member, the electric motor, the transmitter, and the turning angle detector can be removed all at once from the swivel bracket by removing the holding member from the swivel bracket.

Moreover, in the first preferred embodiment of the present invention, the transmitter preferably includes a ball screw to be rotationally driven by the electric motor and a ball nut attached to the ball screw. In this case, the turning angle detector preferably includes a rotation angle detector that detects a rotation angle of the steering shaft by detecting a rotation angle of the ball screw.

Moreover, in the first preferred embodiment of the present invention, the steering arm preferably includes an annular arm portion in which the steering shaft is inserted and that rotates together with the steering shaft, and an arm portion that extends outward from the annular arm portion.

Moreover, in the first preferred embodiment of the present invention, the suspension device preferably further includes a tubular bushing disposed between the steering arm and the transmitter. The bushing preferably includes an outer peripheral surface having a polygonal sectional shape and a cylindrical inner peripheral surface. In this case, the transmitter preferably includes a transmission shaft inserted inside the bushing rotatably relative to the bushing. The steering arm preferably includes a forked arm portion disposed around the bushing, and prevented from rotating relative to the bushing.

Moreover, in the first preferred embodiment of the present invention, the tilting shaft preferably includes at least two divided shafts disposed on the same axis, for example.

Moreover, in the first preferred embodiment of the present invention, the transmitter preferably includes a clutch arranged to transmit torque in a normal rotation direction and a reverse rotation direction from the electric motor side to the steering shaft side, and to shut off torque transmission from the steering shaft side to the electric motor side. In this case, the transmitter preferably further includes a damper disposed closer to the steering shaft than the clutch, and arranged to absorb vibration in a normal rotation direction and a reverse rotation direction.

A second preferred embodiment of the present invention provides a suspension device for an outboard motor, including a clamp bracket, a tilting shaft, a swivel bracket, and a steering shaft. The clamp bracket is to be attached to a hull. The tilting shaft is connected to the clamp bracket. The swivel bracket preferably includes a first support portion arranged to support a first steering mechanism and a second support portion arranged to support a second steering mechanism at a position different from that of the first steering mechanism. The swivel bracket is connected to the tilting shaft. The swivel bracket is rotatable about a central axis of the tilting shaft relative to the clamp bracket. The swivel bracket supports either one of the first steering mechanism and second steering mechanism. The steering shaft is held by the swivel bracket rotatably about a central axis of the steering shaft. The steering shaft is to be driven about the central axis of the steering shaft by either one of the first steering mechanism and second steering mechanism. The steering shaft is to be connected to an outboard motor.

According to this arrangement, the steering shaft to be connected to an outboard motor is held by the swivel bracket rotatably about a central axis (hereinafter, referred to as a "steering axis") of the steering shaft. The swivel bracket is connected to the tilting shaft, and the tilting shaft is connected to the clamp bracket to be attached to a hull. The swivel bracket preferably includes a first support portion arranged to support a first steering mechanism and a second support portion arranged to support a second steering mechanism at a position different from that of the first steering mechanism. The first steering mechanism and the second steering mechanism cause the steering shaft to turn about the steering axis. The swivel bracket is capable of supporting either one steering mechanism selected from the first steering mechanism and the second steering mechanism. Therefore, in either case of using the first steering mechanism or the second steering mechanism, a common swivel bracket can be used. Thus, it is not necessary to prepare a plurality of different specifications of swivel brackets. Accordingly, common use of components can be realized. Moreover, a user can select either steering mechanism, and can also replace one steering mechanism with the other steering mechanism after setting one of the steering mechanisms.

In the second preferred embodiment of the present invention, the swivel bracket preferably includes a placing portion serving as the first support portion on which the first steering mechanism is located and a pair of wall portions serving as the second support portion disposed on both left and right sides of the placing portion. The placing portion and the pair of wall portions may define a recessed disposition space that is opened forward and upward and in which the first steering mechanism is disposed.

Moreover, in the second preferred embodiment of the present invention, the tilting shaft preferably includes at least two divided shafts disposed on the same axis, for example. In this case, the divided shafts may include shaft portions inserted in insertion holes provided in the pair of wall portions and flange portions disposed between the pair of wall portions and having an outer diameter larger than the diameter of the insertion holes.

Moreover, in the second preferred embodiment of the present invention, the suspension device preferably further includes a first steering arm connected to the steering shaft, and arranged to rotate about a central axis of the steering shaft together with the steering shaft. In this case, the swivel bracket preferably further includes a recessed arm housing portion in which the first steering arm is housed.

Moreover, in the second preferred embodiment of the present invention, the suspension device preferably further includes an arm cover attached to the swivel bracket, and covering the arm housing portion. In this case, the suspension device preferably further includes a seal disposed between the arm cover and the swivel bracket. The seal may preferably be a gasket or an O-ring, for example.

Moreover, in the second preferred embodiment of the present invention, the suspension device preferably further includes an arm attaching portion to which a second steering arm is to be removably attached. The arm attaching portion is preferably arranged to rotate about the central axis of the steering shaft together with the steering shaft. Further, the arm attaching portion is preferably also arranged to support the second steering arm attached to the arm attaching portion at a height higher than that of the first steering arm.

Moreover, in the second preferred embodiment of the present invention, the suspension device preferably further includes an electric steering mechanism serving as the first steering mechanism, supported by the first support portion, and arranged to cause the steering shaft to rotate about a central axis of the steering shaft. In this case, the suspension device preferably further includes a first steering arm that rotates about the central axis of the steering shaft together with the steering shaft. The first steering arm preferably includes one end portion (first end portion) connected to the steering shaft and the other end portion (second end portion) connected to the first steering mechanism. In this case, one end portion of the first steering arm is preferably fixed to the steering shaft by at least one of press fitting, bolting, and welding, for example. Specifically, one end portion of the first steering arm may be fixed to the steering shaft by spline press-fitting, for example.

Moreover, in the second preferred embodiment of the present invention, the suspension device preferably further includes the second steering mechanism supported by the second support portion, and arranged to cause the steering shaft to rotate about the central axis of the steering shaft. In this case, the suspension device preferably further includes a second steering arm that rotates about a central axis of the steering shaft together with the steering shaft. The second steering arm preferably includes one end portion (first end portion) connected to the steering shaft and the other end portion (second end portion) connected to the second steering mechanism.

Moreover, in the second preferred embodiment of the present invention, the tilting shaft is preferably supported by the second support portion. In this case, the second steering mechanism is preferably supported by the second support portion via the tilting shaft. Alternatively, the second steering mechanism preferably is directly supported by the second support portion, for example.

Moreover, in the second preferred embodiment of the present invention, the suspension device preferably further includes an arm attaching portion to which one end portion of the second steering arm is removably attached. The arm attaching portion is preferably arranged to rotate about a central axis of the steering shaft together with the steering shaft. One end portion of the second steering arm preferably is removably attached to the arm attaching portion preferably by a bolt, for example.

Moreover, in the second preferred embodiment of the present invention, the second steering mechanism preferably is a hydraulic steering mechanism. A steering mechanism other than a hydraulic steering mechanism may preferably serve as a second steering mechanism, for example.

A third preferred embodiment of the present invention provides a suspension device for an outboard motor, including a clamp bracket, a tilting shaft, a swivel bracket, and a steering shaft. The clamp bracket is to be attached to a hull. The tilting shaft is connected to the clamp bracket. The swivel bracket is connected to the tilting shaft, and is rotatable about a central axis of the tilting shaft relative to the clamp bracket. The steering shaft is held by the swivel bracket rotatably about a central axis of the steering shaft. The steering shaft preferably includes a first connecting portion connectable to a first steering mechanism and a second connecting portion connectable to a second steering mechanism at a position different from that of the first steering mechanism. The steering shaft is to be driven about the central axis of the steering shaft by either one of the first steering mechanism connected to the first connecting portion and the second steering mechanism connected to the second connecting portion. The steering shaft is to be connected to an outboard motor. The same advantageous effects as those of the suspension device according to the second preferred embodiment of the present invention are achieved by the third preferred embodiment of the present invention.

In the third preferred embodiment of the present invention, the first steering mechanism preferably is an electric steering mechanism. The first connecting portion preferably is a first steering arm connected to the steering shaft and arranged to rotate about the central axis of the steering shaft together with the steering shaft.

Moreover, in the third preferred embodiment of the present invention, the second steering mechanism preferably is a hydraulic steering mechanism. The second connecting portion preferably is connectable to the second steering mechanism via a second steering arm arranged to rotate about the central axis of the steering shaft together with the steering shaft. The second steering arm preferably includes one end portion (first end portion) to be connected to the second connecting portion, and the other end portion (second end portion) to be connected to the hydraulic steering mechanism.

A fourth preferred embodiment of the present invention provides a suspension device for an outboard motor, including a steering shaft, a bracket, and at least one bearing. The steering shaft is to be connected to an outboard motor. The bracket defines a shaft insertion hole in which the steering shaft is inserted. The at least one bearing supports the steering shaft rotatably about a central axis of the steering shaft relative to the bracket. The at least one bearing preferably includes a tubular metal portion held by the bracket and surrounding the steering shaft, and a resin layer held at the inner periphery of the metal portion and including a sliding surface that slides in contact with an outer peripheral surface of the steering shaft. The bracket into which the steering shaft is inserted preferably is a swivel bracket connected via a tilting shaft to a clamp bracket that is attachable to a hull, or preferably is a transom bracket that is attachable to a hull, for example.

According to this arrangement, the steering shaft to be connected to an outboard motor is inserted in the shaft insertion hole of the bracket. The steering shaft is supported by the bracket rotatably via the at least one bearing. The bearing preferably includes a tubular metal portion held by the bracket and a resin layer held at the inner periphery of the metal portion. The metal portion surrounds the steering shaft. The resin layer preferably includes a sliding surface that slides in contact with an outer peripheral surface of the steering shaft. Therefore, the steering shaft slides in contact with the resin layer while rotating about a central axis of the steering shaft relative to the bracket.

The metal portion preferably is made of a metal material having a higher strength than that of a resin material. Therefore, the amount of elastic deformation of the bearing is kept small, and rattling of the steering shaft is significantly reduced. Further, because the metal material has a higher dimensional accuracy than that of resin, a clearance between the outer peripheral surface of the steering shaft and the sliding surface can be precisely controlled. Accordingly, not only can manufacturing variations of the steering shaft be further reduced, but wear of an upper bearing and lower bearing can also be significantly reduced. Moreover, because the resin layer that slides in contact with the steering shaft is layered and thinner than the metal portion, an amount of movement of the steering shaft according to elastic deformation of the resin layer is small. Thus, a steering operation for the outboard motor can be controlled with high accuracy.

In the fourth preferred embodiment of the present invention, the bracket preferably is made of the same type of metal material as that of the metal portion. In this case, the metal material preferably is an aluminum alloy, for example.

Moreover, in the fourth preferred embodiment of the present invention, the resin layer preferably is made of a fluorine-contained resin, for example.

Moreover, in the fourth preferred embodiment of the present invention, the metal portion preferably is press-fitted in the shaft insertion hole, for example.

Moreover, in the fourth preferred embodiment of the present invention, the steering shaft preferably extends in the up-down direction. In this case, the at least one bearing preferably includes an upper bearing supporting an upper end portion of the steering shaft and a lower bearing supporting a lower end portion of the steering shaft.

Moreover, in the fourth preferred embodiment of the present invention, the suspension device preferably further includes an upper seal attached to the steering shaft at a height higher than that of the upper bearing and a lower seal attached to the steering shaft at a height lower than that of the lower bearing. The upper seal may preferably be an oil seal or an O-ring, for example. The same applies to the lower seal. Entry of water into the shaft insertion hole is prevented by the upper seal and the lower seal.

Moreover, in the fourth preferred embodiment of the present invention, the suspension device preferably further includes an upper mount support portion disposed at a height higher than that of the upper seal, and attached to the outboard motor via an upper mount, and a lower mount support portion disposed at a height lower than that of the lower seal, and attached to the outboard motor via a lower mount. The upper mount support portion preferably is arranged to rotate about a central axis of the steering shaft together with the steering shaft. Similarly, the lower mount support portion preferably is arranged to rotate about a central axis of the steering shaft together with the steering shaft.

Moreover, in the fourth preferred embodiment of the present invention, the suspension device preferably further includes an arm cover in which an upper end portion of the steering shaft is inserted, and that covers the bracket. The upper seal preferably is press-fitted in the arm cover to seal an area between an upper end portion of the steering shaft and the arm cover.

Moreover, in the fourth preferred embodiment of the present invention, the suspension device preferably further includes an electric steering mechanism that causes the steering shaft to rotate about a central axis of the steering shaft together with the steering shaft.

Moreover, in the fourth preferred embodiment of the present invention, the suspension device preferably further includes a steering arm connected to the steering shaft and rotating about a central axis of the steering shaft together with the steering shaft. In this case, the bracket preferably further includes an arm housing portion housing the steering arm.

A fifth preferred embodiment of the present invention provides a vessel prolusion apparatus including the suspension device according to any one of the first to fourth preferred embodiments of the present invention, and an outboard motor connected to the steering shaft of the suspension device.

The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is side view of a vessel propulsion apparatus according to a preferred embodiment of the present invention.

FIG. **2** is side view of a vessel propulsion apparatus according to a preferred embodiment of the present invention.

FIG. **3** is a plan view of a suspension device according to a preferred embodiment of the present invention.

FIG. **4** is a perspective view of a suspension device according to a preferred embodiment of the present invention.

FIG. **5** is an exploded perspective view of the suspension device according to a preferred embodiment of the present invention.

FIG. **6** is a longitudinal sectional view of the suspension device with the electric steering mechanism removed.

FIG. **7** is a plan view of the suspension device with the electric steering mechanism removed.

FIG. **8** is a sectional view showing a state where the steering shaft is attached to the swivel bracket.

FIG. **9** is an exploded perspective view showing a state before the steering shaft is attached to the swivel bracket.

FIG. **10** is an exploded perspective view showing a state before a first steering arm and an arm cover are attached to the steering shaft.

FIG. **11** is a view enlarged in an upper portion of FIG. **6**.

FIG. **12** is a view enlarged in a lower portion of FIG. **6**.

FIG. **13** is a partial sectional view of an upper bearing and a lower bearing.

FIG. **14** is a perspective view of the suspension device in a full tilt-up state.

FIG. **15** is a side view of the suspension device in a full tilt-up state.

FIG. **16** is a plan view of the suspension device with the electric steering mechanism attached to the swivel bracket.

FIG. **17** is a perspective view showing a state before the electric steering mechanism is attached to the swivel bracket.

FIG. **18** is an exploded perspective view of the electric steering mechanism viewed from above.

FIG. **19** is a perspective view of the electric steering mechanism viewed from below.

FIG. **20** is a longitudinal sectional view showing an attached state of the electric steering mechanism to the swivel bracket.

FIG. **21** is schematic view of the interior of the case viewed from above.

FIG. **22** is schematic view of the interior of the case viewed from above.

FIG. **23** is a plan view of the suspension device with the hydraulic steering mechanism attached to the swivel bracket.

FIG. **24** is a perspective view showing a state before the hydraulic steering mechanism is attached to the swivel bracket.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** and FIG. **2** are side views of a vessel propulsion apparatus **1** according to a preferred embodiment of the present invention. FIG. **3** is a plan view of a suspension device **3** according to a preferred embodiment of the present invention, and FIG. **4** is a perspective view of a suspension device **3** according to a preferred embodiment of the present invention.

FIG. **1** shows the vessel propulsion apparatus **1** in a reference state, and FIG. **2** shows the vessel propulsion apparatus **1** in a full tilt-up state by solid lines. FIG. **3** and FIG. **4** show the suspension device **3** in a reference state. The reference state is a state where a rotation axis (a crank axis A**1**) of a crankshaft **12** extends in an up-down direction and a rotation axis (a propeller axis A**2**) of a propeller **8** extends in a front-rear direction. The "front-rear direction," "left-right direction," "up-down direction" in the following description refer to directions of the vessel propulsion apparatus **1** in a reference state. In the following, unless otherwise specified, description will be given of the vessel propulsion apparatus **1** in a reference state.

As shown in FIG. **1**, the vessel propulsion apparatus **1** includes an outboard motor **2** that produces thrust and a suspension device **3** that supports the outboard motor **2**. The suspension device **3** is attachable to a rear portion of a hull H**1**. The outboard motor **2** is attached to the rear portion of the hull H**1** via the suspension device **3**. As to be described later, the suspension device **3** includes either one of an electric steering mechanism St**1** and a hydraulic steering mechanism St**2**. First, description will be given of the case where the suspension device **3** includes an electric steering mechanism St**1**, and then description will be given of the case where the suspension device **3** includes a hydraulic steering mechanism St**2**.

As shown in FIG. **1**, the outboard motor **2** includes an engine **4** that produces power, a drive shaft **5** connected to the engine **4**, a gear unit **6** connected to the drive shaft **5**, and a propeller shaft **7** connected to the gear unit **6**. The outboard motor **2** further includes an engine cover **9** that houses the engine **4**, an upper case **10** disposed below the engine cover **9**, and a lower case **11** disposed below the upper case **10**.

As shown in FIG. **1**, the engine **4** preferably is an internal combustion engine including a crankshaft **12** that is rotatable about a crank axis A**1** extending in the up-down direction. The drive shaft extends in the up-down direction below the engine **4**. The gear unit **6** is connected to a lower end portion of the drive shaft **5**. A front end portion of the propeller shaft **7** is connected to the gear unit **6**. The propeller shaft **7** extends in the front-rear direction in the lower case **11**. The propeller shaft **7** is rotatable relative to the lower case **11** about a propeller axis A**2** (a central axis of the propeller shaft **7**) extending in the front-rear direction. A rear end portion of the propeller shaft **7** projects rearward from the lower case **11**. A propeller **8** is attached to the rear end portion of the propeller shaft **7**. The propeller **8** rotates about the propeller axis A**2** together with the propeller shaft **7**. A rotation of the crankshaft **12** is transmitted to the propeller **8** via the drive shaft **5**, the gear unit **6**, and the propeller shaft **7**, in order. When the engine **4** rotationally drives the propeller **8** in a normal rotation direction (for example, a clockwise direction when the propeller **8** is viewed from behind), thrust to propel the hull H**1** forward is produced, and when the engine **4** rotationally drives the propeller **8** in a reverse rotation direction (a direction opposite to the normal rotation direction), thrust to propel the hull H**1** rearward is produced.

As shown in FIG. **4**, the suspension device **3** includes a pair of clamp brackets **13** that are attachable to a rear portion of the hull H**1**, a tilting shaft **14** connected to the pair of clamp brackets **13**, a swivel bracket **15** connected to the tilting shaft **14**, and a steering shaft **16** held by the swivel bracket **15**. The suspension device **3** further includes an upper mount support portion **17** fixed to an upper end portion of the steering shaft **16** and a lower mount support portion **18** fixed to a lower end portion of the steering shaft **16**. As shown in FIG. **1**, the outboard motor **2** includes an upper mount Mt**1** and a lower mount Mt**2** disposed in the interior of the outboard motor **2**. The upper mount Mt**1** and the lower mount Mt**2** are disposed at mutually different positions. The upper mount Mt**1** is fixed to the upper mount support portion **17** preferably by a bolt, and the lower mount Mt**2** is fixed to the lower mount support portion **18** preferably by a bolt, for example. Thus, the outboard motor **2** is fixed to the steering shaft **16** at the two upper and lower sites.

As shown in FIG. **3**, the width of the suspension device **3** is narrower than that of the outboard motor **2**. The pair of clamp brackets **13** are removably attached to a transom provided in the stern. The pair of clamp brackets **13** are disposed at an interval in the left-right direction. The pair of clamp brackets **13** are disposed closer to the center of the outboard motor **2** in the width direction than the right end and left end of the outboard motor **2**. The tilting shaft **14** is connected to an upper portion of each clamp bracket **13**. The tilting shaft **14** is disposed above the transom. The tilting shaft **14** extends in the left-right direction. The tilting shaft **14** includes two divided shafts **19** disposed on a tilt axis A**3** (a central axis of the tilting shaft **14**) extending in the left-right direction (refer to FIG. **5**). The two divided shafts **19** are disposed at an interval in the left-right direction. The two divided shafts **19** are fixed to the swivel bracket **15**.

As shown in FIG. **4**, the swivel bracket **15** is disposed between the pair of clamp brackets **13**. The swivel bracket **15** is connected to the clamp brackets **13** via the two divided shafts **19**. The swivel bracket **15** is rotatable up and down relative to the clamp brackets **13** about the tilt axis A**3**. The steering shaft **16** is rotatably held by the swivel bracket **15**. The steering shaft **16** extends in the up-down direction. The steering shaft **16** is rotatable relative to the swivel bracket **15** about a steering axis A**4** (a central axis of the steering shaft **16**) extending in the up-down direction. As previously described, the outboard motor **2** is connected to the steering shaft **16** via the upper mount Mt**1** and the lower mount Mt**2**. Therefore, the outboard motor **2** turns left and right about the steering axis A**4** relative to the swivel bracket **15** together with the steering shaft **16**. Moreover, the outboard motor **2** turns up and down about the tilt axis A**3** relative to the clamp brackets **13** together with the swivel bracket **15** and the steering shaft **16**.

As shown in FIG. **2**, the suspension device **3** includes a power trim/tilt mechanism (hereinafter, referred to as a "PTT **20**") that causes the outboard motor **2** to turn up and down about the tilt axis A**3**. The PTT **20** is disposed between the pair of clamp brackets **15**. The PTT **20** is connected to the clamp brackets **13** and the swivel bracket **15**. The PTT **20** causes the swivel bracket **15** to turn up and down about the tilt axis A**3** relative to the clamp brackets **13**. Accordingly, the outboard motor **2** turns up and down about the tilt axis A**3**.

As shown in FIG. **2**, the PTT **20** causes the outboard motor **2** to turn up and down within a predetermined range including a trim range and a tilt range. The trim range is a range continuous to the tilt range, where the tilt angle of the outboard motor **2** toward the front and rear is smaller than that in the tilt range. The trim range is a range between a full trim-in angle and a full trim-out angle, and the tilt range is a range between a full trim-out angle and a full tilt-up angle. In FIG. **2**, the outboard motor **2** in a full trim-up state (a state where the tilt angle is a full trim-out angle) is shown by alternate long and two short dashed lines, and the outboard motor **2** in a full tilt-up state (a state where the tilt angle is a full tilt-up angle) is shown by solid lines. The PTT **20** is capable of holding the outboard motor **2** at an arbitrary position in the trim range and tilt range.

As shown in FIG. **3**, the suspension device **3** preferably further includes an electric steering mechanism St**1** that causes the outboard motor **2** to turn left and right about the steering axis A**4**. The electric steering mechanism St**1** is held by the swivel bracket **15**. The electric steering mechanism St**1** is connected to the steering shaft **16**. The electric steering mechanism St**1** causes the steering shaft **16** to turn left and right about the steering axis A**4** relative to the swivel bracket **15**. Accordingly, the outboard motor **2** turns left and right about the steering axis A**4**.

As shown in FIG. **3**, the outboard motor **2** is turnable left and right between a maximum right turning position and a maximum left turning position. In FIG. **3**, the outline of the engine cover **9** at the maximum right turning position is shown by an alternate long and short dashed line, and the outline of the engine cover **9** at the maximum left turning position is shown by an alternate long and two short dashed line. The maximum right turning position and the maximum left turning position are positions where the outboard motor **2** tilts left and right. The maximum right turning position and the maximum left turning position are in a left-right symmetrical positional relationship. The electric steering mechanism St**1** causes the outboard motor **2** to turn left and right from a central position located midway between the maximum right turning position and the maximum left turning position. The central position is a position where the propeller axis A**2** perpendicularly or substantially perpendicularly intersects the tilt axis A**3** in a plan view, and extends in the front-rear direction in a plan view. In FIG. **3**, the outline of the engine cover **9** at a straight drive position is shown by a solid line. The electric steering mechanism St**1** is capable of holding the outboard motor **2** at an arbitrary position from the maximum right turning position to the maximum left turning position.

FIG. **5** is an exploded perspective view of the suspension device **3**. FIG. **6** is a longitudinal sectional view of the suspension device **3** with the electric steering mechanism St**1** removed, FIG. **7** is a plan view of the suspension device **3** with the electric steering mechanism St**1** removed, FIG. **8** is a sectional view showing a state where the steering shaft **16** is attached to the swivel bracket **15**, and FIG. **9** is an exploded perspective view showing a state before the steering shaft **16** is attached to the swivel bracket **15**. FIG. **10** is an exploded perspective view showing a state before a first steering arm **32** and an arm cover **34** are attached to the steering shaft **16**.

As shown in FIG. **5**, the swivel bracket **15** includes a plate-shaped placing portion **22** kept in a horizontal posture and a pair of wall portions **23** disposed on both left and right sides of the placing portion **22**. The right wall portion **23** extends upward from a right end portion of the placing portion **22**, and the left wall portion **23** extends upward from a left end portion of the placing portion **22**. The right wall portion **23** extends in the front-rear direction along the right end portion of the placing portion **22**, and the left wall portion **23** extends in the front-rear direction along the left end portion of the placing portion **22**. As shown in FIG. **7**, a front end portion of the placing portion **22** and front end portions of the wall portions **23** are disposed above the transom. The pair of wall portions **23** are opposed to each other in parallel or substantially parallel at an interval in the left-right direction. The right wall portion **23** is disposed inside of the right clamp bracket **13**, and the left wall portion **23** is disposed inside of the left clamp bracket **13**. The right wall portion **23** and the right clamp bracket **13** are adjacent to each other in the left-right direction, and the left wall portion **23** and the left clamp bracket **13** are adjacent to each other in the left-right direction.

As shown in FIG. **7**, each of the wall portions **23** includes a shaft support portion **24** that supports the divided shaft **19** and a case attaching portion **25** to which the electric steering mechanism St**1** is attached. The right divided shaft **19** penetrates through the right shaft support portion **24** and the right clamp bracket **13** in the left-right direction. Similarly, the left divided shaft **19** penetrates through the left shaft support portion **24** and the left clamp bracket **13** in the left-right direction. The divided shafts **19** have tubular shapes extending in the left-right direction. Each of the divided shafts **19** preferably includes a screw portion **19***a*, a shaft portion **19***b* larger in diameter than the screw portion **19***a*, and a flange portion **19***c* larger in diameter than the shaft portion **19***b*. The screw portion **19***a*, the shaft portion **19***b*, and the flange portion **19***c* are disposed in this order from the outside.

As shown in FIG. **7**, the shaft portion **19***b* is inserted in an inner insertion hole **26** that penetrates through the wall portion **23** in the left-right direction. Further, the shaft portion **19***b* is inserted in an outer insertion hole **27** that penetrates through the clamp bracket **13** in the left-right direction. The shaft portion **19***b* is fixed to the wall portion **23** by, for example, press fitting. Therefore, the tilting shaft **14** is fixed to the swivel bracket **15**. The shaft portion **19***b* may be fixed to the wall portion **23** by bolting and/or welding, without limitation to press fitting, and may be fixed to the wall portion **23** by a fixing method other than the above methods, for example. The shaft portion **19***b* is inserted inside a tubular tilt bushing **28** press-fitted in the outer insertion hole **27**. The shaft portion **19***b* is rotatable about the tilt axis A**3** relative to the tilt bushing **28**. Therefore, the clamp bracket **13** rotatably supports the tilting shaft **14** via the tilt bushing **28**.

As shown in FIG. **7**, the flange portion **19***c* is disposed inside of the wall portion **23**. The flange portion **19***c* extends outward from an end portion of the shaft portion **19***b*. The outer diameter of the flange portion **19***c* is larger than the diameter of the inner insertion hole **26**. The flange portion **19***c* is in contact with an inner surface of the wall portion **23**. A movement to the outside of the divided shaft **19** relative to the wall portion **23** is restricted by contact between the wall portion **23** and the flange portion **19***c*. Moreover, the screw portion **19***a* is disposed outside of the clamp bracket **13**. Dropout of the clamp bracket **13** from the divided shaft **19** is prevented by a nut **29** attached to the screw portion **19***a*.

As shown in FIG. **6**, the swivel bracket **15** includes a shaft housing portion **30** that houses the steering shaft **16** rotatably about the steering axis A**4**. The shaft housing portion **30** extends downward from a rear end portion of the placing portion **22**. The steering shaft **16** is inserted in a shaft insertion hole **31** that penetrates through the shaft housing portion **30** in the up-down direction. The steering shaft **16** projects upward from the upper end of the shaft insertion **31**, and projects downward from the lower end of the shaft insertion hole **31**. The upper mount support portion **17** is disposed above the shaft housing portion **30**, and the lower mount support portion **18** is disposed below the shaft housing portion **30**. The upper mount support portion **17** is fixed to an upper end portion of the steering shaft **16**, and the lower mount support portion **18** is fixed to a lower end portion of the steering shaft **16**.

As shown in FIG. **8**, the suspension device **3** includes a first steering arm **32** connected to the steering shaft **16** at a height lower than that of the upper mount Mt**1**. The first steering arm **32** extends forward from an upper portion of the steering shaft **16**. The first steering arm **32** is fixed to the steering shaft **16**.

Therefore, the first steering arm **32** turns about the steering axis A**4** together with the steering shaft **16**. The swivel bracket **15** includes a recessed arm housing portion **33** that is depressed downward from an upper surface of the placing portion **22**. The first steering arm **32** is housed in the arm housing portion **33**. Therefore, the first steering arm **32** is disposed in the interior of the swivel bracket **15**. The suspension device **3** includes a plate-shaped arm cover **34** that covers the arm housing portion **33**. The arm cover **34** is disposed above the first steering arm **32**. As shown in FIG. **9**, the arm cover **34** and the swivel bracket **15** are connected via a second seal **35** (gasket) disposed between the arm cover **34** and the swivel bracket **15**. The second seal **35** seals an area between a peripheral edge portion of the arm cover **34** and the swivel bracket **15**.

As shown in FIG. **9** and FIG. **10**, the first steering arm **32** includes an annular arm portion **36** in which the steering shaft **16** is inserted and a forked (e.g., two forks) arm portion **37** that extends outward from the annular arm portion **36**. The arm cover **34** includes an annular cover portion **38** in which the steering shaft **16** is inserted and a plate portion **39** that extends outward from the annular cover portion **38**. The annular arm portion **36** is fixed to the steering shaft **16**. The annular arm portion **36** may be fixed to the steering shaft **16** by at least one fixing method of press fitting, bolting, and welding, and may be fixed to the steering shaft **16** by a fixing method other than the above methods, for example. The annular arm portion **36** rotates about the steering axis A4 together with the steering shaft **16**. The arm portion **37** is disposed in front of the annular arm portion **36**. The annular cover portion **38** is disposed between the upper mount support portion **17** and the annular arm portion **36**. The plate portion **39** is disposed in front of the annular cover portion **38**. As shown in FIG. **7**, the plate portion **39** is fixed to the swivel bracket **15** preferably by a plurality of bolts, for example. The arm housing portion **33** is covered with the plate portion **39**. The arm portion **37** is disposed below a second opening **40** that penetrates through the plate portion **39** in the up-down direction. The arm housing portion **33** communicates with an area above the arm cover **34** via the second opening **40**.

FIG. **11** is a view enlarged in an upper portion of FIG. **6**, and FIG. **12** is a view enlarged in a lower portion of FIG. **6**. FIG. **13** is a partial sectional view of an upper bearing **41** and a lower bearing **42**.

As shown in FIG. **11**, the suspension device **3** includes a tubular upper bearing **41** disposed inside the shaft insertion hole **31**. As shown in FIG. **12**, the suspension device **3** includes a tubular lower bearing **42** disposed inside the shaft insertion hole **31** at a position lower than that of the upper bearing **41**. As shown in FIG. **11** and FIG. **12**, the steering shaft **16** is inserted in the upper bearing **41** and the lower bearing **42**. The upper bearing **41** supports an upper end portion of the steering shaft **16**, and the lower bearing **42** supports a lower end portion of the steering shaft **16**. The upper bearing **41** and the lower bearing **42** are held by the swivel bracket **15**. Therefore, the steering shaft **16** is connected to the swivel bracket **15** via the upper bearing **41** and the lower bearing **42**. The upper bearing **41** and the lower bearing **42** preferably are sliding bearings. The steering shaft **16** is rotatable about the steering axis A**4** relative to the upper bearing **41** and the lower bearing **42**.

As shown in FIG. **13**, the upper bearing **41** and the lower bearing **42** include a tubular metal portion M**1** and a resin layer R**1** surrounding the steering shaft **16**. The metal portion M**1** includes a tubular portion T**1** extending along the steering axis A**4** and a flange portion F**1** extending radially outward from an end portion of the tubular portion T**1**. The tubular portion T**1** continues throughout the entire circumference. The tubular portion T**1** is press-fitted inside the shaft insertion hole **31**. Therefore, the metal portion M**1** is held by the swivel bracket **15**. The metal portion M**1** is positioned in the axial direction of the steering shaft **16** by contact between the flange portion F**1** and the swivel bracket **15**. As shown in FIG. **11**, the upper bearing **41** is held by the swivel bracket **15** in a posture with the flange portion F**1** facing upward, and as shown in FIG. **12**, the lower bearing **42** is held by the swivel bracket **15** in a posture with the flange portion F**1** facing downward. As shown in FIG. **13**, the resin layer R**1** is coupled with the inner periphery of the tubular portion T**1**. The resin layer R**1** is a coating layer that covers the inner periphery of the tubular portion T**1**, and the thickness of the coating layer (resin layer R**1**) is smaller than that of the tubular portion T**1** (metal portion M**1**). The resin layer R**1** includes a sliding surface that slides in contact with an outer peripheral surface of the steering shaft **16**.

As shown in FIG. **13**, the resin layer R**1** preferably is made of a resin material having a lower strength than that of the steering shaft **16**. The resin material may preferably be a fluorine-contained resin, and more preferably, PTFE (polytetrafluoroethylene resin), for example. Of course, the resin layer R**1** may preferably be made of a resin material other than a fluorine-contained resin. On the other hand, the metal portion M**1** is preferably made of a metal material having a higher strength than that of the resin layer R**1**. The metal material may preferably be a material containing aluminum as a main component such as an aluminum alloy, and may preferably be a material containing iron as a main component such as cast iron or carbon steel. Of course, the metal portion M**1** may preferably be made of a metal material other than these materials. The swivel bracket **15** is preferably made of the same type of metal material as that of the metal portion M**1**. In this case, deterioration of a contact portion between the swivel bracket **15** and the metal portion M**1** due to electrolytic corrosion can be prevented.

As shown in FIG. **11**, the suspension device **3** includes an annular upper seal **43** disposed inside the annular cover portion **38**. As shown in FIG. **12**, the suspension device **3** includes an annular lower seal **44** disposed inside the shaft insertion hole **31**. The upper seal **43** may preferably be an oil seal or an O-ring, for example. The same applies to the lower seal **44**. The upper seal **43** is press-fitted inside the annular cover portion **38**. The lower seal **44** is press-fitted inside the shaft housing portion **30**. Therefore, the upper seal **43** is held by the arm cover **34**, and the lower seal **44** is held by the swivel bracket **15**. As shown in FIG. **11** and FIG. **12**, the steering shaft **16** is inserted inside the upper seal **43** and the lower seal **44**. The upper seal **43** is attached to the steering shaft **16** at a position higher than that of the upper bearing **41**, and the lower seal **44** is attached to the steering shaft **16** at a position lower than that of the lower bearing **42**. The upper mount support portion **17** is disposed at a position higher than that of the upper seal **43**, and the lower mount support portion **18** is disposed at a position lower than that of the lower seal **44**. A tubular upper washer W**1** is disposed between the upper seal **43** and the upper mount support portion **17**, and a tubular lower washer W**2** is disposed between the lower seal **44** and the lower mount support portion **18**.

As shown in FIG. **11** and FIG. **12**, the upper seal **43** seals an area between the inner peripheral surface of the annular cover portion **38** and the outer peripheral surface of the steering shaft **16**. Therefore, entry of water from above into the shaft insertion hole **31** is prevented by the upper seal **43**. On the other hand, the lower seal **44** seals an area between the inner peripheral surface of the shaft housing portion **30** and the outer peripheral surface of the steering shaft **16**. Therefore, entry of water from below into the shaft insertion hole **31** is prevented by the lower seal **44**. The arm housing portion **33** communicates with the shaft insertion hole **31** (refer to FIG. **6**). The peripheral edge portion of the arm cover **34** that covers the arm housing portion **33** and the swivel bracket **15** are sealed by the second seal **35** therebetween. Therefore, the second seal **35** prevents entry of water into the arm housing portion **33**. Thus, entry of water into the shaft insertion hole **31** from the arm housing portion **33** is prevented.

FIG. **14** is a perspective view of the suspension device **3** in a full tilt-up state, and FIG. **15** is a side view of the suspension device **3** in a full tilt-up state. In FIG. **15**, the outboard motor **2** and the swivel bracket **15** in a full trim-out state are shown by alternate long and two short dashed lines.

As shown in FIG. **14**, the PTT**20** preferably includes a plurality of cylinders (for example, two trim cylinders **45** and a tilt cylinder **46**) that cause the outboard motor **2** to turn up and down. The trim cylinders **45** and the tilt cylinder **46** preferably are hydraulic cylinders, for example. The PTT**20** includes an oil tank **47** (refer to FIG. **5**) that reserves a hydraulic oil, a hydraulic pump **48** that sends a hydraulic oil to the trim cylinders **45** and the tilt cylinder **46**, and an electric motor **49** that drives the hydraulic pump **48**. The trim cylinders **45**, the tilt cylinder **46**, the oil tank **47**, the hydraulic pump **48**, and the electric motor **49** are held by a frame **50** disposed between the pair of clamp brackets **13**.

As shown in FIG. **14**, the two trim cylinders **45** are disposed in parallel or substantially parallel at an interval in the left-right direction. Each trim cylinder **45** is tilted to the front and rear so that the upper end of the trim cylinder **45** is located closer to the rear than the lower end of the trim cylinder **45**. The tilt cylinder **46** is disposed so that the tilt cylinder **46** is located between the two trim cylinders **45** when viewed in the front-rear direction. An upper end portion of the tilt cylinder **46** is disposed at a position higher than that of each trim cylinder **45**. The hydraulic pump **48** and the electric motor **49** are disposed above one trim cylinder **45**, and the oil tank **47** is disposed above the other trim cylinder **45**. The electric motor **49** is disposed above the hydraulic pump **48**.

As shown in FIG. **14**, each trim cylinder **45** includes a cylinder main body **45***a* and a trim rod **45***b* that extend along a central axis of the trim cylinder **45**. Similarly, the tilt cylinder **46** includes a cylinder main body **46***a* and a tilt rod **46***b* that extend along a central axis of the tilt cylinder **46**. Each trim rod **45***b* projects upward from the upper end of the cylinder main body **45***a*. Each cylinder main body **45***a* is fixed to the frame **50**. As shown by the alternate long and two short dashed lines in FIG. **15**, in a full trim-out state, a contact portion **51** provided on the swivel bracket **15** is supported at the tip of each trim rod **45***b*. On the other hand, as shown in FIG. **14**, the tilt rod **46***b* projects upward from the upper end of the cylinder main body **46***a*. An upper end portion of the tilt rod **46***b* is connected to the swivel bracket **15** via an upper pin **52** extending in the left-right direction. A lower end portion of the cylinder main body **46***a* is connected to the frame **50** via a lower pin (not shown) extending in the left-right direction. The tilt rod **46***b* is turnable about the upper pin **52** relative to the swivel bracket **15**, and the cylinder main body **46***a* is turnable about the lower pin relative to the frame **50**.

When the hydraulic pump **48** is driven by the electric motor **49**, a hydraulic oil is supplied from the hydraulic pump **48** to at least either of the trim cylinders **45** and the tilt cylinder **46**. When a hydraulic oil is supplied from the hydraulic pump **48** to the cylinder main body **45***a* of each trim cylinder **45**, the amount of projection of each trim rod **45***b* changes. Similarly, when a hydraulic oil is supplied from the hydraulic pump **48** to the cylinder main body **46***a* of the tilt cylinder **46**, the amount of projection of the tilt rod **46***b* changes.

As shown in FIG. **15**, when the amount of projection of the tilt rod **46***b* increases, the swivel bracket **15** is pushed up by the tilt rod **46***b*, and the outboard motor **2** turns upward about the tilt axis A**3**. Moreover, when the amount of projection of the trim rod **45***b* increases in a state of the outboard motor **2** located in the trim range, the swivel bracket **15** is pushed up by the tilt rod **45***b*, and the outboard motor **2** turns upward about the tilt axis A**3**. The tilt cylinder **46** supports the outboard motor **2** within the trim range and tilt range. Moreover, the two trim cylinders **45** support the outboard motor **2** within the trim range. That is, when the tilt angle of the outboard motor **2** exceeds the full trim-out angle, the tip of each trim rod **45***b* separates from the contact portion **51** of the swivel bracket **15**. Therefore, in the tilt range, the outboard motor **2** is supported by the tilt cylinder **46**.

FIG. **16** is a plan view of the suspension device **3** with the electric steering mechanism St**1** attached. In FIG. **16**, illustration of an upper cover **58** is omitted. FIG. **17** is a perspective view showing a state before the electric steering mechanism St**1** is attached to the swivel bracket **15**. FIG. **18** is an exploded perspective view of the electric steering mechanism St**1** viewed from above. FIG. **19** is a perspective view of the electric steering mechanism St**1** viewed from below. FIG. **20** is a longitudinal sectional view showing an attached state of the electric steering mechanism St**1** to the swivel bracket **15**.

As shown in FIG. **16**, the electric steering mechanism St**1** includes a case **53**, an electric motor **54** housed in the case **53**, a transmitter **55** that transmits power from the electric motor **54** to the steering shaft **16** side, and a turning angle detector **56** that detects a turning angle of the outboard motor **2**. The electric motor **54**, the transmitter **55**, and the turning angle detector **56** are held by the case **53**. The case **53** is removably attached to the swivel bracket **15**. Therefore, the electric motor **54**, the transmitter **55**, and the turning angle detector **56** are removably attached to the swivel bracket **15** via the case **53**. When the case **53** is removed from the swivel bracket **15**, the electric motor **54**, the transmitter **55**, and the turning angle detector **56** are also removed from the swivel bracket **15**.

As shown in FIG. **16**, at least a portion of the case **53** is disposed between the pair of wall portions **23** of the swivel bracket **15**. The case **53** is located on the placing portion **22** of the swivel bracket **15**. As shown in FIG. **17**, the placing portion **22** and the pair of wall portions **23** define a recessed disposition space S**1** depressed downward. The disposition space S**1** is not only opened upward, but is opened also forward and rearward. As shown in FIG. **16**, at least a portion of the case **53** is disposed in the disposition space S**1**. The upper mount support portion **17** is disposed behind the case **53**. The two divided shafts **19** are disposed on both left and right sides of a front end portion of the case **53**. Therefore, the tilt axis A**3** intersects the case **53**. The case **53** is disposed below the engine cover **9** (refer to FIG. **3**).

As shown in FIG. **18**, the case **53** includes a box-shaped housing **57** with an opening provided in its upper portion, an upper cover **58** that covers the upper portion of the housing **57**, and a pair of side covers **59** provided on both left and right sides of the housing **57**. The housing **57** includes a front wall **57***a* and a rear wall **57***b* opposed to each other in the front-rear direction, a pair of left and right sidewalls **57***c* (a right sidewall **57***c* and a left sidewall **57***c*) opposed to each other in the left-right direction, and a bottom wall **57***d* that constitutes a bottom portion of the housing **57**. The right side cover **59** is attached to the right sidewall **57***c* preferably by a plurality of bolts, and the left side cover **59** is attached to the left sidewall **57***c* preferably by a plurality of bolts, for example. An opening provided in each sidewall **57***c* is covered with the side cover **59**. The right sidewall **57***c* of the housing **57** and the right side cover **59** constitute a right side portion of the case **53**, and the left sidewall **57***c* of the housing **57** and the left side cover **59** constitute a left side portion of the case **53**. As shown in FIG. **16**, the right wall portion **23** is opposed to the right side portion of the case **53**, and the left wall portion **23** is opposed to the left side portion of the case **53**. Each side cover **59** is disposed between the housing **57** and the wall portion **23**. Each side cover **59** is opposed to the inner surface of the wall portion **23** at an interval in the left-right direction.

As shown in FIG. **18**, the case **53** includes a pair of left and right projections **60** that project laterally from the right side portion and left side portion of the case **53**, respectively, and pluralities of first boss portions **61** that project laterally from the right side portion and left side portion of the case **53**, respectively. The pair of projections **60** are disposed closer to the front than the pluralities of first boss portions **61**. As shown in FIG. **16**, the right projection **60** is disposed on the right wall portion **23**, and the left projection **60** is disposed on the left wall portion **23**. As shown in FIG. **17**, each up-down bolt B**1** is attached to the wall portion **23** from above via an up-down mounting hole **62** that penetrates through the projection **60** in the up-down direction. Therefore, each projection **60** is removably fixed to the wall portion **23**.

As shown in FIG. **16**, the plurality of first boss portions **61** are interposed between the side portion of the case **23** and the wall portion **23**. Each first boss portion **61** extends in the left-right direction. Each first boss portion **61** includes a flat end surface, and the inner surface of the wall portion **23** opposed to the end surface of the first boss portion **61** is also flat. The end surface of each first boss portion **61** is in surface contact with the inner surface of the wall portion **23**. As shown in FIG. **17**, each left-right bolt B**2** is attached to the first boss portion **61** from the side via a left-right mounting hole **63** that penetrates through the wall portion **23** in the left-right direction. Therefore, the plurality of first boss portions **61** are removably fixed to the wall portion **23** in a state of the end surface of each first boss portion **61** and the inner surface of the wall portion **23** being in surface contact. Thus, each wall portion **23** is supported from the inside by the case **53**. Each wall portion **23** is connected to the side portion of the case **53** in a state opposed to the sidewall **57***c* of the housing **57** at an interval in the left-right direction.

As shown in FIG. **19**, the case **53** includes an annular opening portion **57***e* provided in the bottom wall **57***d* of the housing **57**. The opening portion **57***e* projects downward from a lower surface of the bottom wall **57***d*. The opening portion **57***e* defines a first opening **64** that penetrates the bottomwall **57***d* of the housing **57** in the up-down direction. The first opening **64** preferably is a slit that is elongated in the left-right direction. The first opening **64** causes the interior of the case **53** and the exterior of the case **53** communicate with each other. A portion of the transmitter **55** (a transmission shaft **79** to be described later) projects from the interior of the case **53** to the exterior of the case **53** through the first opening **64**. As shown in FIG. **20**, the suspension device **3** includes an annular first seal **65** attached to the opening **57***e*. The first seal **65** surrounds the first opening **64**. The first opening **64** is opposed to the second opening **40** provided in the arm cover **34**. The case **53** is fixed to the swivel bracket **15** in a state of the first opening **64** and the second opening **40** facing each other. The first opening **64** communicates with the arm housing portion **33** via the second opening **40**. Therefore, the interior of the case **53** communicates with the arm housing portion **33** via the first opening **64** and the second opening **40**.

As shown in FIG. **20**, the first seal **65** is disposed between the case **53** and the arm cover **34**. The projections **60** and the first boss portions **61** are fixed to the swivel bracket **15** preferably by the up-down bolts B**1** and the left-right bolts B**2**, respectively, at positions where the first seal **65** is sandwiched in the up-down direction between the case **53** and the swivel bracket **15**. Therefore, the case **53** is fastened to the swivel bracket **15** in a state of the first seal **65** being sandwiched in the up-down direction between the case **53** and the swivel bracket **15**. Accordingly, the case **53** and the arm cover **34** are sealed therebetween.

There is a seal that seals an area between the upper cover **58** and the housing **57** and between the side cover **59** and the housing **57**, so that entry of water into the case **53** from a site other than the first opening **64** is prevented. The interior of the case **53** communicates with the arm housing portion **33** via the first opening **64** and the second opening **40**. The arm housing portion **33** communicates with the shaft insertion hole **31**. As previously described, entry of water into the shaft insertion hole **31** is prevented by the upper seal **43** and the lower seal **44**, and entry of water into the arm housing portion **33** from the peripheral edge portion of the arm cover **34** is prevented by the second seal **35**. Accordingly, entry of water into the case **53** is prevented. Thus, adhesion of water to the constituents in the case **53** such as the electric motor **54** is prevented.

FIG. **21** and FIG. **22** are schematic views of the interior of the case **53** viewed from above. FIG. **21** shows a state before the steering shaft **16** and the first steering arm **32** are turned, and FIG. **22** shows a state after the steering shaft **16** and the first steering arm **32** are turned. In the following, the electric steering mechanism St**1** will be described with reference to FIG. **18**, FIG. **20**, FIG. **21**, and FIG. **22**.

As shown in FIG. **21**, the electric motor **54** is disposed inside the case **53** in a posture with a rotation shaft **66** extending in the left-right direction. A plurality of wires **67** including electrical wires extend to the exterior of the case **53** from the electric motor **54** through a wiring hole that penetrates through the case **53**. The electric motor **54** produces power (torque) to turn the steering shaft **16** about the steering axis A**4**. The power of the electric motor **54** is transmitted to the steering shaft **16** through a transmission channel connecting the electric motor **54** and the first steering arm **32**. The electric motor **54** is disposed in the interior of the case **53**, and the first steering arm **32** is disposed on the exterior of the case **53**, so that the transmission channel extends from the interior of the case **53** to the exterior of the case **53** through the first opening **64**. The transmitter **55** is disposed on the transmission channel. The transmitter **55** includes a clutch **68**, a coupling **69**, a decelerator **70**, and a motion converter **71** disposed on the transmission channel. The clutch **68**, the coupling **69**, the decelerator **70**, and the motion converter **71** are held by the case **53** in the interior of the house **53**.

As shown in FIG. **21**, the clutch **68** and the coupling **69** are disposed on a rotation axis of the electric motor **54** (on a central axis of the rotation shaft **66**). The clutch **68** is disposed between the electric motor **54** and the coupling **69**. The clutch **68** is a reverse input shutoff clutch that transmits torque in a normal rotation direction and a reverse rotation direction from the electric motor **54** side to the steering shaft **16** side, and shuts off torque transmission from the steering shaft **16** side to the electric motor **54** side. The coupling **69** is disposed closer to the steering shaft **16** than the clutch **68** (a downstream side of the transmission channel). As shown in FIG. **18**, the coupling **69** is an elastic coupling including a pair of engaging members **69***b* that engage each other via an elastic body **69***a*. Therefore, the coupling **69** functions as a damper that absorbs vibration in a normal rotation direction and a reverse rotation direction. Thus, a reverse input that is input into the coupling **69** from a downstream side of the coupling **69** is transmitted to the clutch **63** while being dampened by the coupling **69**. Accordingly, the clutch **68** is prevented from receiving a large reverse input.

As shown in FIG. **21**, the decelerator **70** is disposed in the left side portion of the case **53**. The decelerator **70** is disposed between the coupling **69** and the motion converter **71** in terms of a power transmission direction. The decelerator **70** decelerates a rotation from the coupling **69**, and transmits the decelerated rotation to the motion converter **71** side. The decelerator **70** includes a plurality of reduction gears. In FIG. **21**, shown is a case where the decelerator **70** includes four reduction gears (a first reduction gear **72**, a second reduction gear **73**, a third reduction gear **74**, and a fourth reduction gear **75**).

As shown in FIG. **21**, the four reduction gears are held by the case **53** rotatably about an axis extending in the left-right direction. The first reduction gear **72**, the second reduction gear **73**, the third reduction gear **74**, and the fourth reduction gear **75** are disposed along the transmission channel in this order from the upstream side. The most upstream-side first reduction gear **72** is disposed on the rotation axis of the electric motor **54**, and the most downstream-side fourth reduction gear **75** is disposed on a rotation axis of a ball screw **77** to be described later.

As shown in FIG. **21**, the first reduction gear **72**, the third reduction gear **74**, and the fourth reduction gear **75** are supported by the case **53** rotatably via a bearing. The second reduction gear **73** is supported by an unlocking shaft **76** rotatably via a bearing. The unlocking shaft **76** is attached to the side cover **59** from the side. The unlocking shaft **76** extends in the left-right direction. The unlocking shaft **76** is attached to the side cover **59** so as to be axially movable relative to the side cover **59**. The second reduction gear **73** moves axially together with the unlocking shaft **76**.

The second reduction gear **73** is movable inside the case **53** between an engaging position and a disengaging position. The engaging position is a position where the first reduction gear **72** and the second reduction gear **73** are engaged with each other and the second reduction gear **73** and the third reduction gear **74** are engaged with each other. The disengaging position is a position where the second reduction gear **73** is retracted to the side of the first reduction gear **72** and the third reduction gear **74**, and engagement of the first reduction gear **72** and the second reduction gear **73** and engagement of the second reduction gear **73** and the third reduction gear **74** are released. In FIG. **21** and FIG. **22**, a state where the second reduction gear **73** is disposed at the engaging position is shown. The second reduction gear **73** is disposed at either one of the engaging position and disengaging position by an operator operating the unlocking shaft **76**.

In a state where the second reduction gear **73** is disposed at the engaging position, torque transmitted to the first reduction gear **72** from the coupling **69** is transmitted to the third reduction gear **74** via the second reduction gear **73**. Then, the torque transmitted to the third reduction gear **74** is transmitted to the fourth reduction gear **75** from the third reduction gear **74**. Moreover, in this state, the clutch **68** arranged to shut off a reverse input is connected to the second reduction gear **73** via the first reduction gear **72** and the coupling **69**, so that even when a reverse input (torque) is input to the second reduction gear **73** from the third reduction gear **74**, the second reduction gear **73** does not rotate.

On the other hand, in a state where the second reduction gear **73** is disposed at the disengaging position, the first reduction gear **72** is not in engagement with the second reduction gear **73**, so that torque transmitted to the first reduction gear **72** from the coupling **69** is not transmitted to the second reduction gear **73**, and the first reduction gear **72** runs freely. Similarly, in this state, the third reduction gear **74** is not in engagement with the second reduction gear **73**, so that torque transmitted to the third reduction gear **74** from the fourth reduction gear **75** is not transmitted to the second reduction gear **73**, and the third reduction gear **74** runs freely. Thus, in this state, rotation is not transmitted to the downstream side from the upstream side of the second reduction gear **73**, and rotation is not transmitted to the upstream side from the downstream side of the second reduction gear **73**.

The outboard motor **2** is connected to the transmitter **55** via the steering shaft **16** and the first steering arm **32**. When an operator pushes the outboard motor **2** left and right, this force (reverse input) is transmitted to the fourth reduction gear **75**, and torque is transmitted to the third reduction gear **74** from the fourth reduction gear **75**. In the state where the second reduction gear **73** is disposed at the engaging position, a rotation of the second reduction gear **73** is prevented by the clutch **68**, so that even when the operator pushes the outboard motor **2** left and right in this state, the outboard motor **2** does not move. On the other hand, in the state where the second reduction gear **73** is disposed at the disengaging position, the second reduction gear **73** is not in engagement with the third reduction gear **74**, so that when the operator pushes the outboard motor **2** left and right in this state, the outboard motor **2** turns left and right about the steering axis A**4**.

As shown in FIG. **21**, the motion converter **71** includes a ball screw **77** to be rotationally driven by the electric motor **54** and a ball nut **78** attached to the ball screw **77** via a plurality of balls. The ball screw **77** and the ball nut **78** are disposed closer to the rear than the electric motor **54** in the case **53**. The ball screw **77** extends in the left-right direction behind the electric motor **54**. Both end portions of the ball screw **77** are supported by the case **53** via bearings. The ball screw **77** is turnable relative to the case **53** about a central axis of the ball screw **77**. The rotation axis of the ball screw **77** and the rotation axis of the electric motor **54** are parallel or substantially parallel to each other. The ball screw **77** is connected to the electric motor **54** via the clutch **68**, the coupling **69**, and the decelerator **70**. The ball screw **77** rotates together with the fourth reduction gear **75** of the decelerator **70**. When the ball screw **77** rotates about the central axis of the ball screw **77**, the ball nut **78** moves in the axial direction of the ball screw **77** along the ball screw **77**. Accordingly, a rotation of the ball screw **77** is converted to a linear motion of the ball nut **78**.

The transmitter **55** includes a transmission shaft **79** that transmits power from the motion converter **71** side to the first steering arm **32** side. As shown in FIG. **20**, the transmission shaft **79** extends downward from the ball nut **78**. The transmission shaft **79** projects to the exterior of the case **53** from the interior of the case **53** through the opening portion **57***e* provided in the bottom wall **57***d* of the housing **57**. The transmission shaft **79** is disposed on the transmission channel. The transmission shaft **79** moves in the axial direction (left-right direction) of the ball screw **77** together with the ball nut **78**. The transmission shaft **79** may be integrated with the ball nut **78**, or may be a member different from the ball nut **78** fixed to the ball nut **78**.

As shown in FIG. **20**, the suspension device **3** includes a tubular first bushing **80** and second bushing **81** in which the transmission shaft **79** is inserted. The first bushing **80** is disposed above the second bushing **81**. The first bushing **80** surrounds the transmission shaft **79** in the interior of the case **53**. The first bushing **80** is disposed inside the opening **57***e* of the housing **57**. On the other hand, the second bushing **81** surrounds the transmission shaft **79** at the exterior of the case **53**. The second bushing **81** is disposed inside the arm housing portion **33**. The arm portion **37** of the first steering arm **32** is disposed around the second bushing **81**. Therefore, the second bushing **81** is disposed between the first steering arm **32** and the transmission shaft **79**.

As shown in FIG. **18**, the first bushing **80** includes an outer peripheral surface having a polygonal sectional shape and a cylindrical inner peripheral surface. The outer peripheral surface of the first bushing **80** includes two mutually parallel or substantially parallel first flat portions **82**. One first flat portion **82** is provided at a front surface of the first bushing **80**, and the other first flat portion **82** is provided at a rear surface of the first bushing **80**. As shown in FIG. **20**, the two first flat portions **82** are opposed in the front-rear direction to an inner surface of the opening portion **57***e* extending in the left-right direction. A rotation of the ball nut **78** about the central axis of the ball screw **77** is restricted by contact between the first flat portion **82** and the opening portion **57***e*. Further, the two first flat portions **82** slide in contact with the inner surface of the opening portion **57***e*, while guiding the ball nut **78** and the transmission shaft **79** in the left-right direction along the opening portion **57***e*. Therefore, the first bushing **80** is preferably made of a material having a lower strength than that of the first steering arm **32** and the transmission shaft **79**, such as a resin material.

As shown in FIG. **18**, the second bushing **81** includes an outer peripheral surface having a polygonal sectional shape and a cylindrical inner peripheral surface. The outer peripheral surface of the second bushing **81** includes two mutually parallel or substantially parallel second flat portions **83**. As shown in FIG. **21**, the arm portion **37** of the first steering arm **32** is disposed around the second bushing **81**. The second flat portion **83** is opposed to an inner surface of the arm portion **37**. A rotation of the first steering arm **32** relative to the second bushing **81** is restricted by contact between the second flat portion **83** and the inner surface of the arm portion **37**. The second bushing **81** slides in contact with an outer peripheral surface of the transmission shaft **79**, while rotating about a central axis of the transmission shaft **79** relative to the transmission shaft **79** together with the first steering arm **32**. Therefore, the second bushing **81** is preferably made of a material having a lower strength than that of the first steering arm **32** and the transmission shaft **79**, such as a resin material.

As shown in FIG. **21** and FIG. **22**, when the electric motor **54** rotates the rotation shaft **66**, a rotation of the electric motor **54** is transmitted to the ball screw **77** via the clutch **68**, the coupling **69**, and the decelerator **70**, and the ball nut **78** and the transmission shaft **79** move in the left-right direction. Accordingly, the first bushing **80** and the second bushing **81** move in the left-right direction, and the first steering arm **32** is pushed in the left-right direction by the second bushing **81**. Thus, the first steering arm **32** turns left and right about the steering axis A**4**, and the second bushing **81** turns about the central axis of the transmission shaft **79** relative to the transmission shaft **79**. Accordingly, the outboard motor **2** and the steering shaft **16** turn left and right about the steering axis A**4**. When the electric motor **54** rotates the rotation shaft **66** in a normal rotation direction, the outboard motor **2** turns right, and when the electric motor **54** rotates the rotation shaft **66** in a reverse rotation direction (a direction opposite to the normal rotation direction), the outboard motor **2** turns left. Consequently, the outboard motor **2** is disposed at any position from the maximum right turning position to the maximum left turning position.

The turning angle of the outboard motor **2** is detected by the turning angle detector **56**. As shown in FIG. **21**, the turning angle detector **56** is disposed in the right side portion of the case **53**. The turning angle detector **56** is a rotation angle detector that detects a rotation angle (rotational position) of the steering shaft **16** by detecting a rotation angle (rotational position) of the ball screw **77**. The turning angle detector **56** preferably is a linear sensor that detects a rotation angle of the steering shaft **16** by detecting an amount of movement of the ball nut **78** in the axial direction. The turning angle detector **56** preferably includes a plurality of gears **84** and a sensor **85**. The plurality of gears **84** are disposed between the right side cover **59** and the right side wall **57***c* of the housing **57**. The plurality of gears **84** rotate in accordance with a rotation of the ball screw **77**. The rotation of the ball screw **77** is decelerated by the plurality of gears **84** in sequence. The sensor **85** detects a rotation angle of the ball screw **77** based on a rotation angle of the most downstream-side gear **84**. Accordingly, the turning angle of the outboard motor **2** is detected.

Next, description will be given of the case where the suspension device **3** includes the hydraulic steering mechanism St**2**.

FIG. **23** is a plan view of the suspension device **3** with the hydraulic steering mechanism St**2** attached. FIG. **24** is a perspective view showing a state before the hydraulic steering mechanism St**2** is attached to the swivel bracket **15**.

As shown in FIG. **23** and FIG. **24**, when the suspension device **3** includes the hydraulic steering mechanism St**2**, a spacer **86** and a second steering arm **87** are provided in the suspension device **3**.

As shown in FIG. **24**, the spacer **86** is a block extending in the left-right direction preferably having a triangular or substantially triangular shape in a side view, for example. As shown in FIG. **23**, the spacer **86** is disposed between the pair of wall portions **23**. The spacer **86** is located on the placing portion **22**. The spacer **86** is disposed in the disposition space S**1**. The spacer **86** is disposed above the second opening **40** provided in the arm cover **34**. The second opening **40** is blocked by the spacer **86**. The spacer **86** and the arm cover **34** are sealed therebetween. Accordingly, entry of water into the arm housing portion **33** is prevented.

As shown in FIG. **23**, the spacer **86** includes pluralities of second boss portions **88** that project laterally from a right side portion and left side portion of the spacer **86**, respectively. Each second boss portion **88** extends in the left-right direction. Each second boss portion **88** includes a flat end surface, and the end surface of each second boss portion **88** is in surface contact with the inner surface of the wall portion **23**. The positional relationship of the pluralities of second boss portions **88** preferably is the same as the positional relationship of the pluralities of first boss portions **61** provided in the case **53** of the electric steering mechanism St**1**. Therefore, each second boss portion **88** is opposed to the left-right mounting hole **63** (refer to FIG. **17**) that penetrates through the wall portion **23** in the left-right direction. The spacer **86** is fixed to the pair of wall portions **23** by the pluralities of left-right bolts B**2**. Therefore, the plurality of second boss portions **88** are removably fixed to the wall portion **23** in a state of the end surface of each second boss portion **88** and the inner surface of the wall portion **23** being in surface contact. Thus, each wall portion **23** is supported from the inside by the spacer **86**.

As shown in FIG. **23**, the second steering arm **87** passes over the spacer **86** and extends to the hydraulic steering mechanism St**2** from the upper mount support portion **17**. The upper mount support portion **17** includes an arm attaching portion **89** to which one end portion of the second steering arm **87** is removably attached. The second steering arm **87** is removably attached to the arm attaching portion **89** preferably by an arm bolt B**3**, for example. The second steering arm **87** is supported by the arm attaching portion **89** above the swivel bracket **15**. The first steering arm **32** to be connected to the electric steering mechanism St**1** is disposed in the interior of the swivel bracket **15**. Therefore, the second steering arm **87** is supported by the arm attaching portion **89** at a position higher than that of the first steering arm **32**. The second steering arm **87** rotates about the steering axis A**4** together with the steering shaft **16**. The other end portion of the second steering arm **87** is connected to the hydraulic steering mechanism St**2**.

As shown in FIG. **23**, the hydraulic steering mechanism St**2** includes a hydraulic cylinder **90** that produces power, a pair of attaching arms **91** attached to the hydraulic cylinder **90**, and an attaching shaft **92** attached to the pair of attaching arms **91**. The hydraulic cylinder **90** is a double rod double acting cylinder. The hydraulic cylinder **90** includes a cylinder tube **90***a* to which a hydraulic oil is supplied and a piston rod **90***b* that penetrates through the cylinder tube **90***a* in the left-right direction. The attaching shaft **92** extends in the left-right direction behind the hydraulic cylinder **90**. The right attaching arm **91** connects a right end portion of the piston rod **90***b* and a right end portion of the attaching shaft **92**, and the left attaching arm **91** connects a left end portion of the piston rod **90***b* and a left end portion of the attaching shaft **92**. The pair of attaching arms **91** are disposed in parallel or substantially parallel to each other.

As shown in FIG. **24**, the attaching shaft **92** extends in the left-right direction along the tilt axis A**3**. As shown in FIG. **23**, the attaching shaft **92** penetrates through the two divided shafts **19** in the left-right direction. A right end portion of the attaching shaft **92** is disposed on the side further than the right clamp bracket **13** and a left end portion of the attaching shaft **92** is disposed on the side further than the left clamp bracket **13**. The attaching shaft **92** is removably attached to the tilting shaft **14** preferably by two bolts B**4**, for example. The attaching shaft **92** is supported by the tilting shaft **14**. Therefore, the hydraulic steering mechanism St**2** is supported by the pair of wall portions **23** via the tilting shaft **14**. The hydraulic steering mechanism St**2** is supported by the swivel bracket **15** closer to the front than the disposition space S1 in which the electric steering mechanism St**1** is disposed.

As shown in FIG. **23**, the other end portion of the second steering arm **87** is connected to the cylinder tube **90***a* via a turning shaft **93**. The other end portion of the second steering arm **87** is turnable relative to the cylinder tube **90***a* about a central axis of the turning shaft **93**. When a hydraulic oil is supplied to the inside of the cylinder tube **90***a*, the cylinder tube **90***a* moves in the left-right direction relative to the piston rod **90***b*. The piston rod **90***b* is prevented from moving in the left-right direction by the attaching arm **91** and the attaching shaft **92**. Therefore, when a hydraulic oil is supplied to the inside of the cylinder tube **90***a*, the cylinder tube **90***a* moves in the left-right direction relative to the clamp bracket **13** and the swivel bracket **15**.

When the cylinder tube **90***a* moves in the left-right direction, the other end portion of the second steering arm **87** turns relative to the cylinder tube **90***a* about the central axis of the turning shaft **93** while moving in the left-right direction. Accordingly, the second steering arm **87** turns left and right about the steering shaft A**4**. Thus, the outboard motor **2** and the steering shaft **16** turn left and right about the steering axis A**4**. The outboard motor **2** is disposed at any position from the maximum right turning position to the maximum left turning position by the hydraulic steering mechanism St**2**.

As above, in the present preferred embodiment, the swivel bracket **15** includes the placing portion **22** serving as a first support portion capable of supporting the electric steering mechanism St**1** and the pair of wall portions **23** serving as a second support portion capable of supporting the hydraulic steering mechanism St**2** at a position different from that of the electric steering mechanism St**1**. The swivel bracket **15** is capable of supporting either one of the electric steering mechanism St**1** and the hydraulic steering mechanism St**2**. Therefore, in either case of using the electric steering mechanism St**1** or the hydraulic steering mechanism St**2**, the common swivel bracket **15** can be used. Thus, it is not necessary to prepare a plurality of different specifications of swivel brackets **15**. Accordingly, common use of components can be realized.

Moreover, the electric steering mechanism St**1** includes the case **53** serving as a holding member to be located on the placing member **22**, the electric motor **54** that produces power, and the transmitter **55** that transmits power from the electric motor **54** to the steering shaft **16** side. The case **53** is removably attached to the swivel bracket **15**. The electric motor **54** and the transmitter **55** are held by the case **53**. Therefore, by removing the case **53** from the swivel bracket **15**, the case **53**, the electric motor **54**, and the transmitter **55** can be removed all at once from the swivel bracket **15**. Thus, the electric steering mechanism St**1** can be maintained in a state removed from the swivel bracket **15**. Consequently, maintenance can be performed more efficiently than when the electric steering mechanism St**1** is integrated with the swivel bracket **15**. Further, the weight of the suspension device **3** can be greatly reduced when the electric steering mechanism St**1** is unnecessary. Furthermore, it is not necessary to replace the swivel bracket **15** when the electric steering mechanism St**1** is damaged.

Moreover, each of the upper bearing **41** and the lower bearing **42** that rotatably support the steering shaft **16** includes a tubular metal portion M**1** held by the swivel bracket **15** and a resin layer R**1** coupled with the inner periphery of the metal portion M**1**. The resin layer R**1** includes a sliding surface that slides in contact with the outer peripheral surface of the steering shaft **16**. The metal portion M**1** is made of a metal material having a higher strength than that of the resin material. Therefore, the amount of elastic deformation of the upper bearing **41** and the lower bearing **42** is kept small, and rattling of the steering shaft **16** relative to the swivel bracket **15** is significantly reduced. Further, because the metal material has a higher dimensional accuracy than that of resin, a clearance between the outer peripheral surface of the steering shaft **16** and the sliding surface can be precisely controlled. Accordingly, not only can manufacturing variations of the steering shaft **16** be further reduced, but wear of the upper bearing **41** and the lower bearing **42** can also be significantly reduced. Moreover, because the resin layer R**1** is layered and thinner than the metal portion M**1**, variation associated with elastic deformation of the resin layer R**1** of the steering shaft **16** is small. Therefore, rattling of the steering shaft **16** can be significantly reduced. Thus, a steering operation of the outboard motor **2** can be controlled with high accuracy.

Other Preferred Embodiments

Although various preferred embodiment of the present invention have been described above, the present invention is not limited to the content of the above-described preferred embodiments, and can be variously modified within the scope of the appended claims.

For example, in the above-described preferred embodiments, the electric motor of the electric steering mechanism is preferably disposed in the interior of the case. However, when a motor including a waterproof structure where entry of water into the interior of the motor is prevented is used as the electric motor, the electric motor may be disposed on the exterior of the case.

Also, in the above-described preferred embodiments, the first boss portions preferably extend from the case to the wall portion side. However, the first boss portions may be provided only at the wall portion, and extend from the inner surface of the wall portion to the case side. Further, the first boss portions may be provided at both of the case and the wall portion. Moreover, the side surface of the case and the inner surface of the wall portion may be in surface contact without the first boss portions being provided at the case or wall portion.

Also, in the above-described preferred embodiments, the hydraulic steering mechanism preferably is connected to the wall portions of the swivel bracket via the tilting shaft. However, the hydraulic steering mechanism may be directly connected to the wall portions. Moreover, the steering mechanism to be connected to the wall portions is not limited to a hydraulic steering mechanism, and may be an electric steering mechanism, for example.

Also, in the above-described preferred embodiments, the tilting shaft preferably is divided into two. However, the tilting shaft may be divided into three or more, and may be an integrated member that penetrates through a pair of clamp brackets in the left-right direction.

Also, in the above-described preferred embodiments, the steering shaft preferably is held by the swivel bracket via the two bearings (upper bearing and lower bearing). However, the number of bearings that support the steering shaft may be one, and may be three or more.

Also, in the above-described preferred embodiments, the steering shaft preferably is held by the swivel bracket and turns up and down with a turn of the outboard motor about the tilt axis. However, the steering shaft may be held by a transom bracket that is attachable to a transom, and arranged not to turn even when the outboard motor turns up and down about the tilt axis.

Also, in the above-described preferred embodiments, the decelerator **70** preferably is disposed in the left side portion of the case **53**, and the turning angle detector **56** preferably is disposed in the right side portion of the case **53**. However, the decelerator **70** may be disposed in the right side portion of the case **53**, and the turning angle detector **56** may be disposed in the left side portion of the case **53**.

The structure of the transmitter of the electric steering mechanism is not limited to the structure of the above-described preferred embodiments, and may be the structure disclosed in Japanese Patent Application No. 2010-230851 and U.S. patent application Ser. No. 13/212,247. The entire disclosures of Japanese Patent Application No. 2010-230851 and U.S. patent application Ser. No. 13/212,247 are incorporated herein by reference.

Various other design modifications can be made within the scope of the matters described in the scope of claims.

The present application corresponds to Japanese Patent Application Nos. 2012-065801, 2012-065802, and 2012-065803 filed on Mar. 22, 2012 in the Japan Patent Office, and the entire disclosures of these applications are incorporated herein by reference.

While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A suspension device for an outboard motor, the suspension device comprising:
- a clamp bracket to be attached to a hull;
- a tilting shaft connected to the clamp bracket;
- a swivel bracket connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket;
- a steering shaft held by the swivel bracket rotatably about a central axis of the steering shaft, and to be connected to an outboard motor;
- a holding member placed on a placing portion provided in the swivel bracket, and removably attached to the swivel bracket;
- an electric motor held by the holding member, and arranged to produce power to rotate the steering shaft about the central axis of the steering shaft; and
- a transmitter held by the holding member, and arranged to transmit power from the electric motor to the steering shaft; wherein
- the holding member includes a case that holds the electric motor in an interior of the case and is provided with a first opening; and
- the transmitter transmits power from the electric motor to the steering shaft through the first opening.

2. The suspension device for an outboard motor according to claim **1**, further comprising a steering arm connected to the steering shaft, and arranged to rotate together with the steering shaft about the central axis of the steering shaft; wherein
- the suspension device causes the outboard motor to turn by transmitting power to the steering arm from the transmitter.

3. The suspension device for an outboard motor according to claim **1**, further comprising a steering arm connected to the steering shaft, and arranged to rotate together with the steering shaft about the central axis of the steering shaft; wherein
- the swivel bracket includes an arm housing portion in which the steering arm is housed, the arm housing portion communicating with the first opening provided in the case; and
- the transmitter transmits power on a transmission channel that extends to an exterior of the case from the interior of the case through the first opening, and connects the electric motor and the steering arm.

4. The suspension device for an outboard motor according to claim **3**, further comprising a first seal disposed between the case and the swivel bracket, and surrounding the first opening of the case.

5. The suspension device for an outboard motor according to claim **4**, further comprising a fastening member fastening the case and the swivel bracket with the first seal sandwiched between the case and the swivel bracket.

6. The suspension device for an outboard motor according to claim **3**, further comprising an arm cover covering the arm housing portion, and provided with a second opening causing the first opening of the case and the arm housing portion to communicate with each other.

7. The suspension device for an outboard motor according to claim **6**, further comprising a second seal disposed between the arm cover and the swivel bracket.

8. The suspension device for an outboard motor according to claim **1**, further comprising a connecting member removably connecting the holding member and the swivel bracket.

9. The suspension device for an outboard motor according to claim **1**, further comprising a turning angle detector held by the holding member, and arranged to detect a rotation angle of the steering shaft.

10. The suspension device for an outboard motor according to claim **2**, wherein the steering arm includes an annular arm portion in which the steering shaft is inserted and that rotates together with the steering shaft, and an arm portion that extends outward from the annular arm portion.

11. A vessel prolusion apparatus comprising:

the suspension device according to claim **1**; and

an outboard motor connected to the steering shaft.

12. A suspension device for an outboard motor, the suspension device comprising:

a clamp bracket to be attached to a hull;

a tilting shaft connected to the clamp bracket;

a swivel bracket connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket;

a steering shaft held by the swivel bracket rotatably about a central axis of the steering shaft, and to be connected to an outboard motor;

a holding member placed on a placing portion provided in the swivel bracket, and removably attached to the swivel bracket;

an electric motor held by the holding member, and arranged to produce power to rotate the steering shaft about the central axis of the steering shaft;

a transmitter held by the holding member, and arranged to transmit power from the electric motor to the steering shaft; and

a connecting member removably connecting the holding member and the swivel bracket; wherein

the swivel bracket includes a pair of wall portions disposed on both left and right sides of the placing portion, and connected to a side portion of the holding member.

13. The suspension device for an outboard motor according to claim **12**, wherein the connecting member includes a bolt that removably connects the side portion of the holding member and the pair of wall portions.

14. The suspension device for an outboard motor according to claim **12**, further comprising a boss portion projecting from at least one of the holding member and the swivel bracket, and interposed between the side portion of the holding member and the pair of wall portions.

15. A suspension device for an outboard motor, the suspension device comprising:

a clamp bracket to be attached to a hull;

a tilting shaft connected to the clamp bracket;

a swivel bracket connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket;

a steering shaft held by the swivel bracket rotatably about a central axis of the steering shaft, and to be connected to an outboard motor;

a holding member placed on a placing portion provided in the swivel bracket, and removably attached to the swivel bracket;

an electric motor held by the holding member, and arranged to produce power to rotate the steering shaft about the central axis of the steering shaft;

a transmitter held by the holding member, and arranged to transmit power from the electric motor to the steering shaft; and

a turning angle detector held by the holding member, and arranged to detect a rotation angle of the steering shaft; wherein

the transmitter includes a ball screw to be rotationally driven by the electric motor and a ball nut attached to the ball screw, and

the turning angle detector includes a rotation angle detector that detects the rotation angle of the steering shaft by detecting a rotation angle of the ball screw.

16. A suspension device for an outboard motor, the suspension device comprising:

a clamp bracket to be attached to a hull;

a tilting shaft connected to the clamp bracket;

a swivel bracket connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket;

a steering shaft held by the swivel bracket rotatably about a central axis of the steering shaft, and to be connected to an outboard motor;

a holding member placed on a placing portion provided in the swivel bracket, and removably attached to the swivel bracket;

an electric motor held by the holding member, and arranged to produce power to rotate the steering shaft about the central axis of the steering shaft;

a transmitter held by the holding member, and arranged to transmit power from the electric motor to the steering shaft;

a steering arm connected to the steering shaft, and arranged to rotate together with the steering shaft about the central axis of the steering shaft; and

a tubular bushing including an outer peripheral surface having a polygonal sectional shape and a cylindrical inner peripheral surface, and disposed between the steering arm and the transmitter; wherein

the suspension device causes the outboard motor to turn by transmitting power to the steering arm from the transmitter;

the transmitter includes a transmission shaft inserted inside the bushing rotatably relative to the bushing; and

the steering arm includes a forked arm portion disposed around the bushing, and restricted from rotation relative to the bushing.

17. A suspension device for an outboard motor, the suspension device comprising:

a clamp bracket to be attached to a hull;

a tilting shaft connected to the clamp bracket;

a swivel bracket connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket;

a steering shaft held by the swivel bracket rotatably about a central axis of the steering shaft, and to be connected to an outboard motor;

a holding member placed on a placing portion provided in the swivel bracket, and removably attached to the swivel bracket;

an electric motor held by the holding member, and arranged to produce power to rotate the steering shaft about the central axis of the steering shaft; and

a transmitter held by the holding member, and arranged to transmit power from the electric motor to the steering shaft; wherein

the tilting shaft includes two divided shafts disposed on a same axis.

18. A suspension device for an outboard motor, the suspension device comprising:

a clamp bracket to be attached to a hull;

a tilting shaft connected to the clamp bracket;

a swivel bracket connected to the tilting shaft, and rotatable about a central axis of the tilting shaft relative to the clamp bracket;

a steering shaft held by the swivel bracket rotatably about a central axis of the steering shaft, and to be connected to an outboard motor;

a holding member placed on a placing portion provided in the swivel bracket, and removably attached to the swivel bracket;

an electric motor held by the holding member, and arranged to produce power to rotate the steering shaft about the central axis of the steering shaft; and

a transmitter held by the holding member, and arranged to transmit power from the electric motor to the steering shaft; wherein

the transmitter includes:

a clutch arranged to transmit torque in a normal rotation direction and a reverse rotation direction from the electric motor to the steering shaft, and to shut off torque transmission from the steering shaft to the electric motor; and

a damper disposed closer to the steering shaft than the clutch, and arranged to absorb vibration in the normal rotation direction and in the reverse rotation direction.

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